

2016 : The ultimate PHENIX Run

PHENIX run16 coordinator

Denis Jouan

Institut de physique nucléaire, Orsay
CNRS/IN2P3, Université paris sud

The plan for run 16

For Run 16 the PAC recommends the following (*in order of priority*):

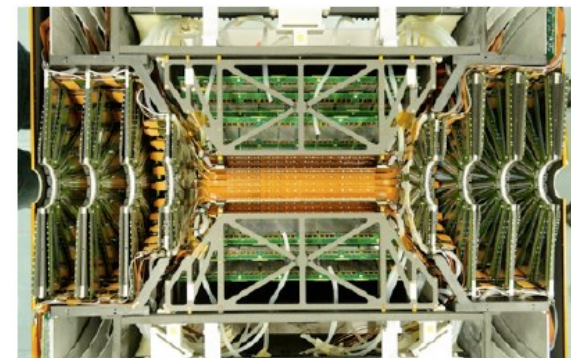
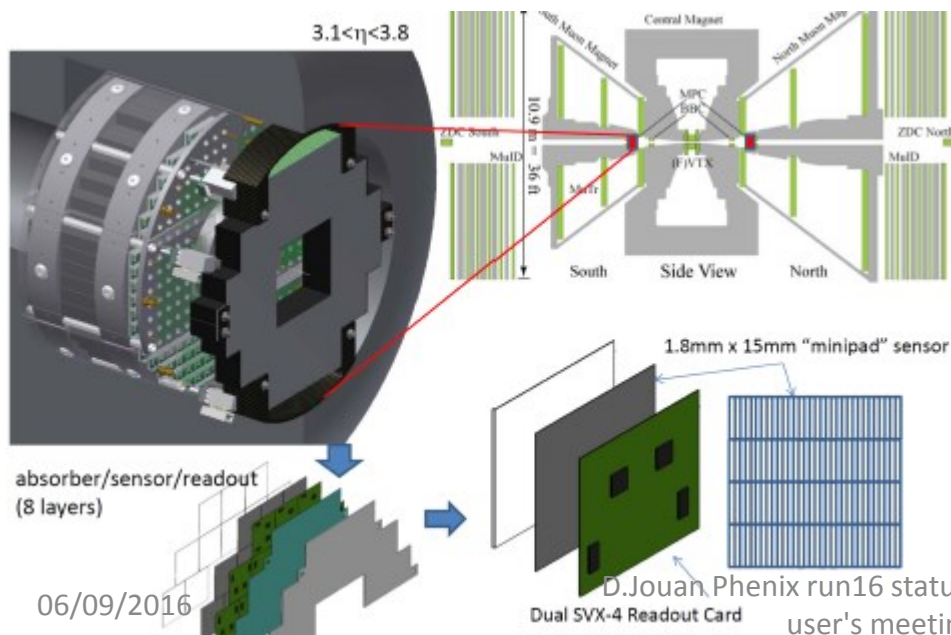
1. 10 weeks Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV
2. 5 weeks for a small system beam energy scan. This program can be realized with
 - a. Au+polarized proton collisions for a set of energies chosen among 200, 62, 39 and 20 GeV to optimize the physics output, or
 - b. d+Au collisions at 200, 62, 39, and 20 GeV
3. 2 weeks of polarized p+p collisions at $\sqrt{s} = 62$ GeV
4. Up to 4 weeks of Au+Au collisions at $\sqrt{s_{NN}} = 62$ GeV

The challenge:
will it be
possible too ?

[phenix BUP] This plan will yield
2.4 billion, 230 million, 110 million, and 7 million
central **d+Au** events at energies of
200, 62, 39, 20 GeV respectively.

In the case of a shorter 15-week running time, the Au+Au run at $\sqrt{s_{NN}} = 200$ GeV remains the highest priority, in order to fulfill the mission of the STAR HFT upgrade, which is a DOE MIE project. However, this running scenario will severely limit the physics output from the PHENIX collaboration in the *last year* of the experiment.

- Last PHENIX run
- Detector: with FVTX, VTX and MPC-EX(+MPC)
- AuAu 200: Increasing the dataset, HF-> double the data, complete HF measurement
- dAu energy scan : onset of QGP in small systems



Vertex detector is necessary for Heavy Flavor studies, and Can increase coverage for correlations

- **Au+Au @ 200 GeV for 10 weeks**

Goal is 1.8 /nb (12 billion minimum bias events)

recorded within $|z| < 10$ cm (added to the 2.3 /nb recorded in the longer and very successful Run-14)

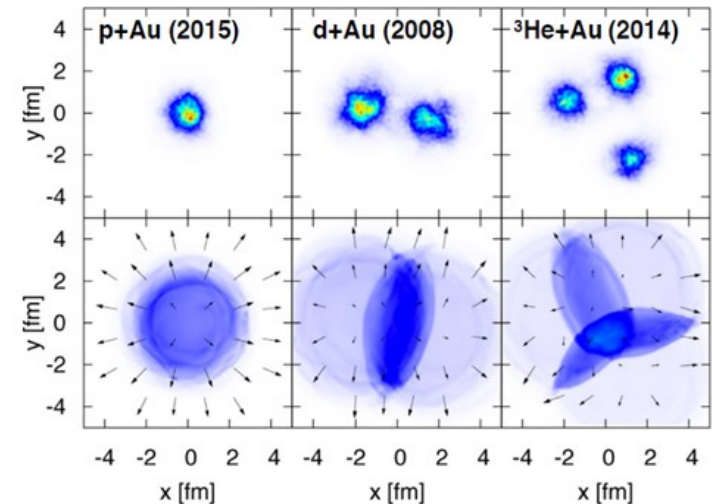
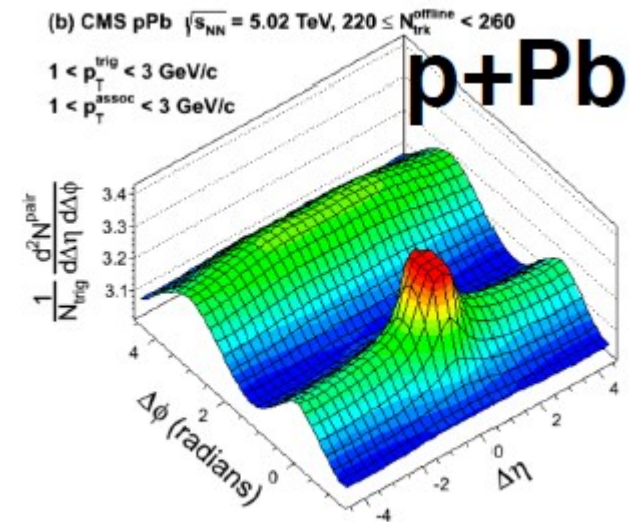
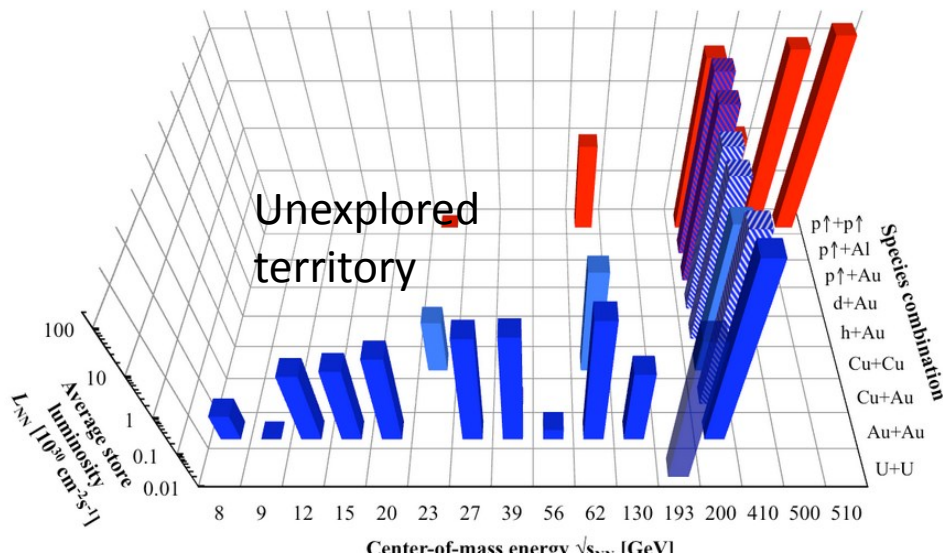
- An increase of statistics, in particular if the z-vertex distribution is sharper.
- With the ultimate PHENIX set up, bringing additionnal information for tracking in HF studies: double the Au+Au dataset, complete HF measurement

Long range correlations,
flow has been observed in
small systems

What is the smallest possible droplet of QGP ?

RHIC makes possible the study of the
evolution with geometry (2014, 2015 ,
and with energy! 2016 !!

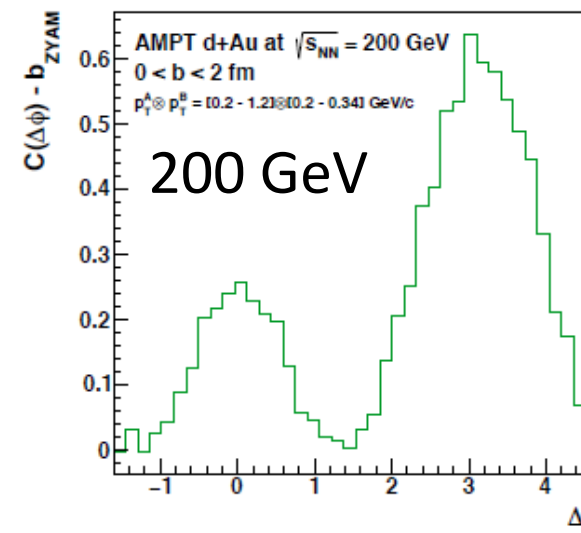
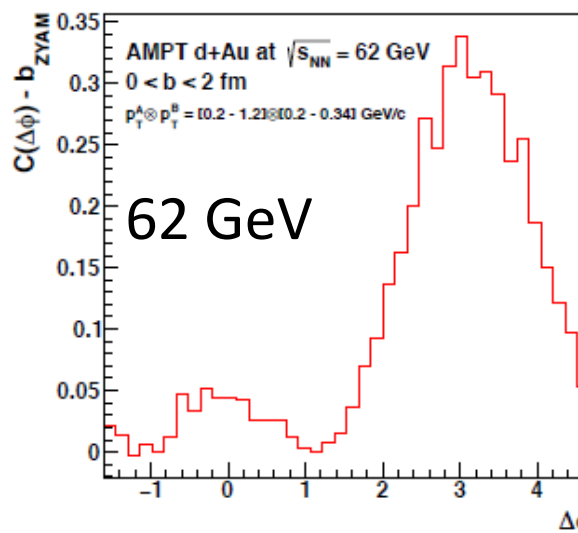
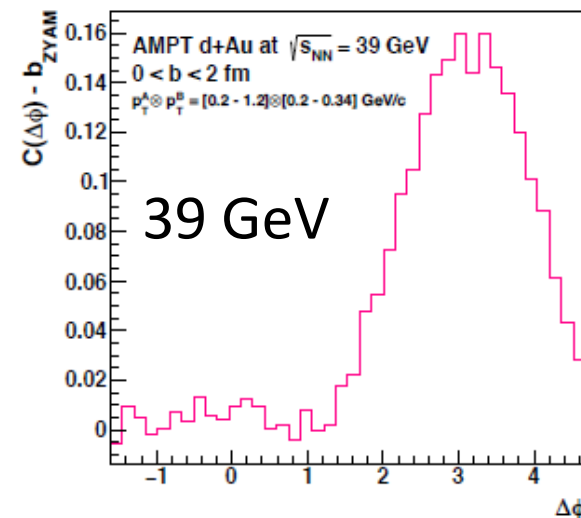
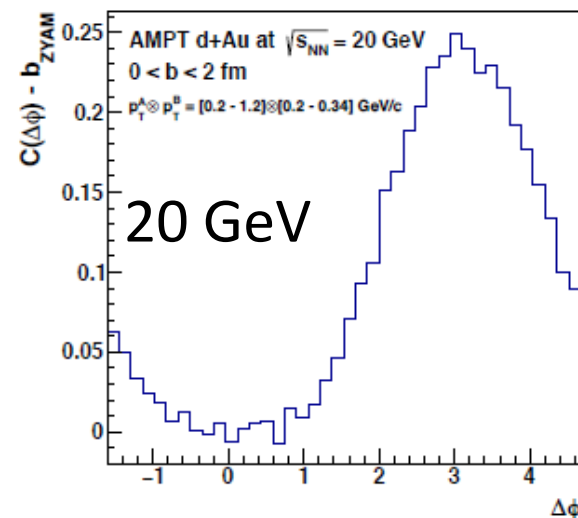
RHIC energies, species combinations and luminosities (Run-1 to 15)



Courtesy of Björn Schenke

PAC: “unique and impressive versatility of the
RHIC accelerator in providing a variety of
collisions systems and energies.”

dAu BES at RHIC: evolution of flow and thermalisation in small systems (*the « rise of the ridge » ?*)



d-Au : 5 weeks, 4 energies

- “**Five to seven weeks** of running to perform a small system beam energy scan (PAC) »

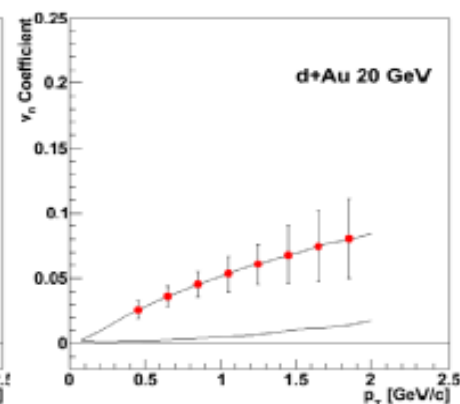
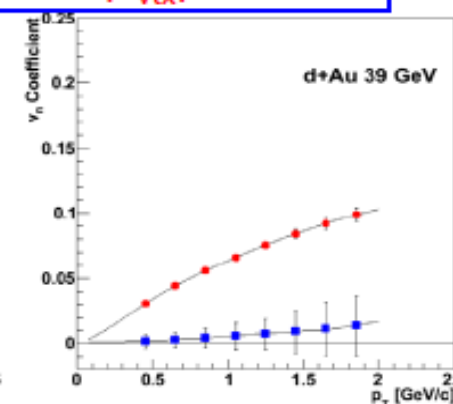
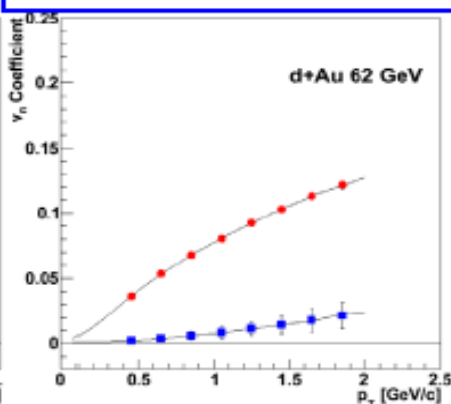
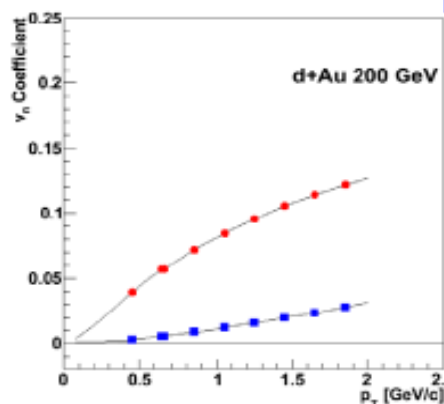
Our optimized choice for **5 weeks**:

- 20 GeV 1.5 week 9M (BUP: 7M)
- 39 GeV 1.5 week 110M (110M)
- 62 GeV 1. week 160M (230M)
- 200 GeV 1. week 1.6 B (2.4B)

Allowing a complete energy scan in the same detection conditions, and keeping BUP and PAC goals of measuring the **excitation function** of 2-particle **correlations** and **V2**, and possibly - the first **BES** measurement of **V3 in small systems** at RHIC

Projections (based on SONIC) for 5 weeks BES

0-5% central events within $|z_{\text{vtx}}| < 10$ cm



1 week, 1.6 B evts

robust baseline
 v_2 and v_3
measurements

Factor of ~20 stat
increase from Run8
FVTX improved EP

same detector
conditions=>
systematics control
in the BES

1 week, 160 M evts

All 3 lower energies for robust v_2 measurements to establish

- role of pre-equilibrium stage
- role of hadronic stage

v_3 at lower energy:
more sensitive to time
spent in QGP

Statistically significant
measurements for
both v_2 and v_3

1.5 weeks, 110M

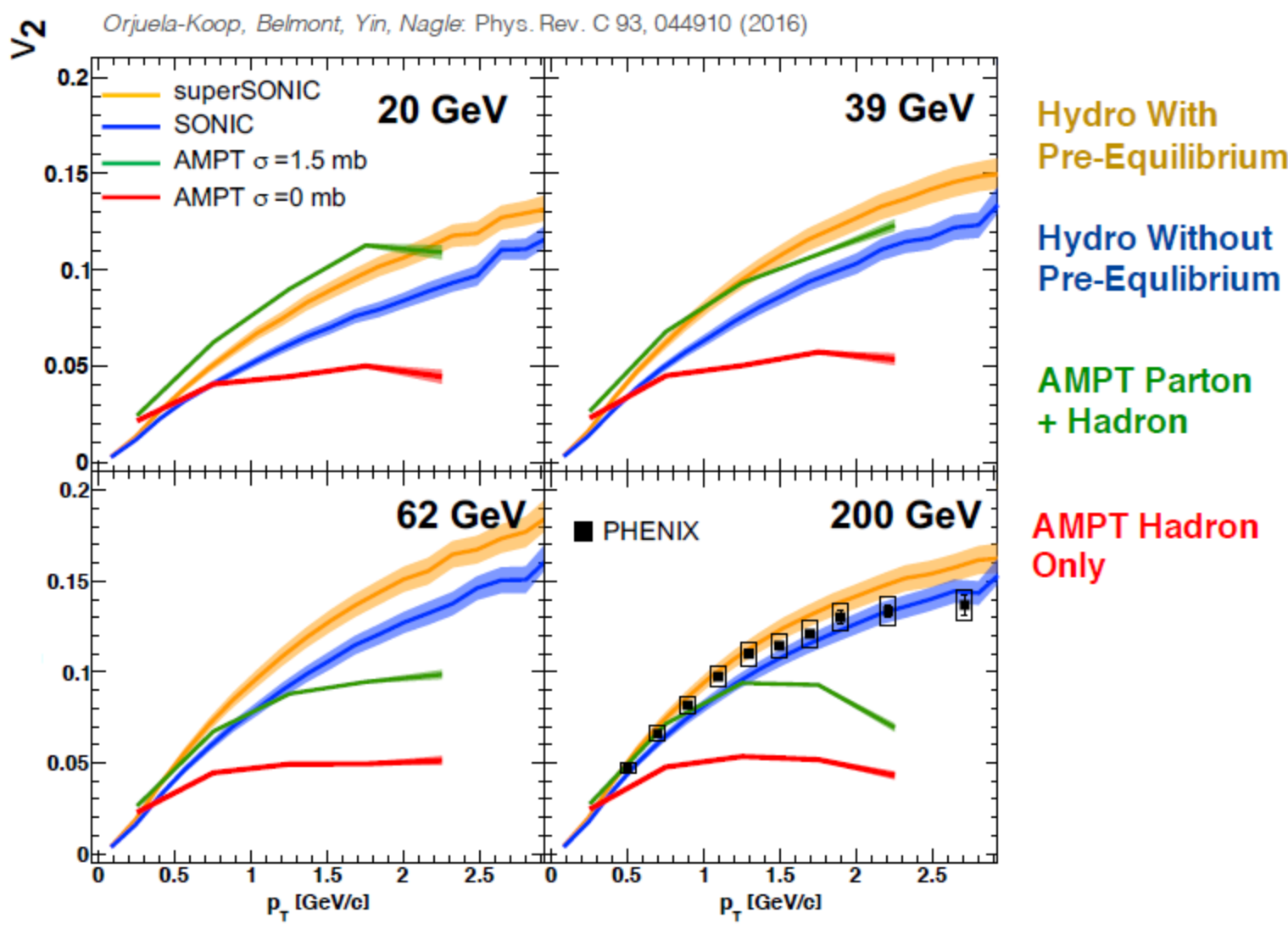
Does v_3 collapse at lower energy ?
upper limits of v_3 can be established

Transition region
for v_3 collapse

1.5 weeks, 9M

Largest lever arm
for v_2
measurements

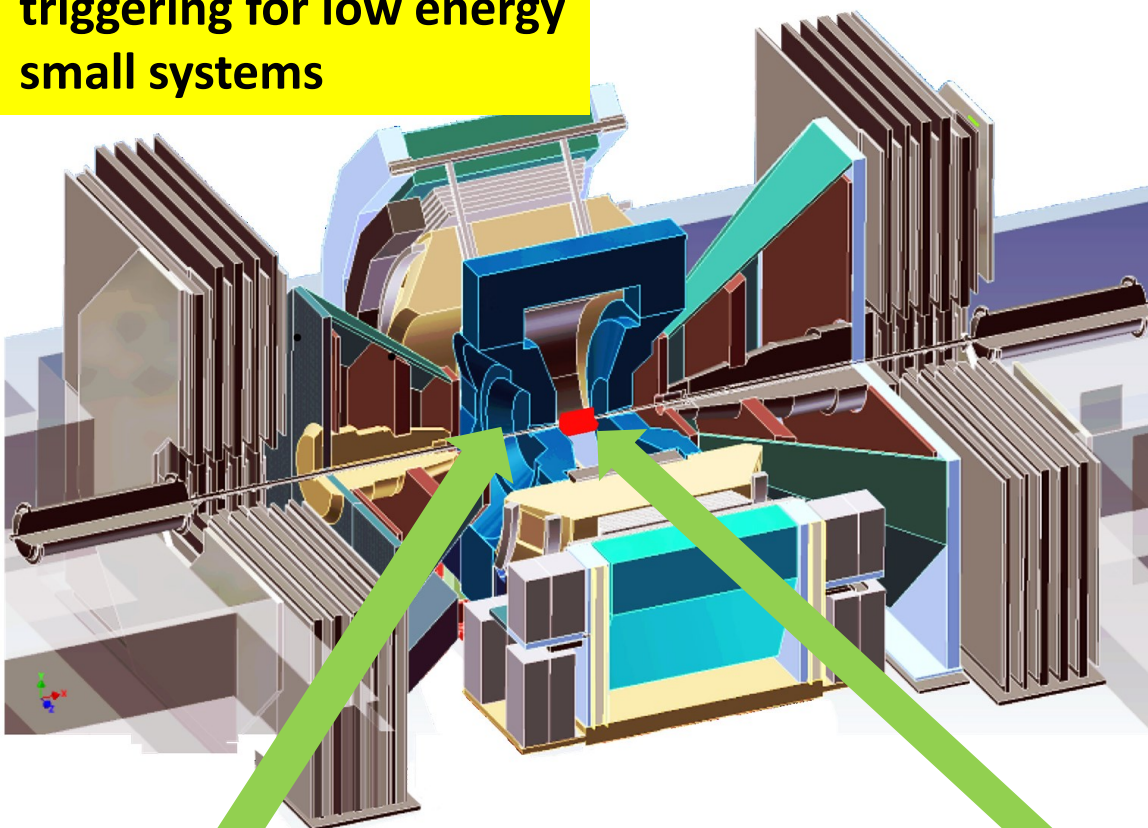
d+Au Beam Energy Scan



Stay tuned for PHENIX Run16 results!

The detector

No new detector, but improvements in triggering for low energy small systems



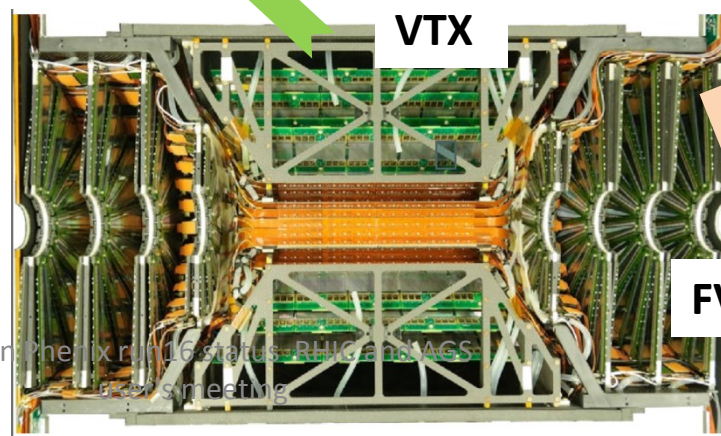
$3.1 < |\eta| < 4.$

extension of the triggers



BBC

64 Cherenkov quartz



VTX

FVTX

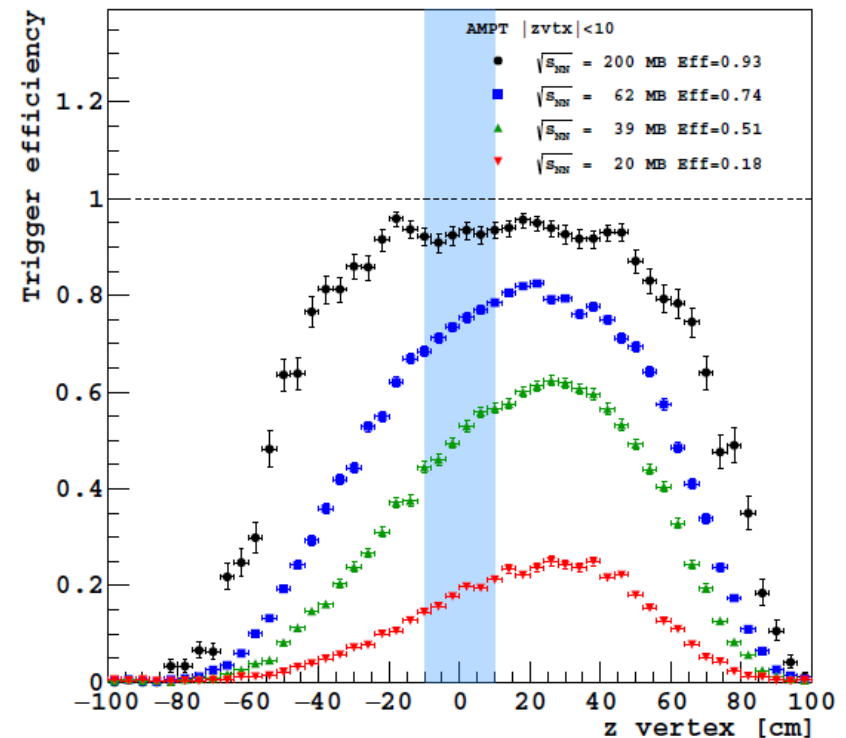
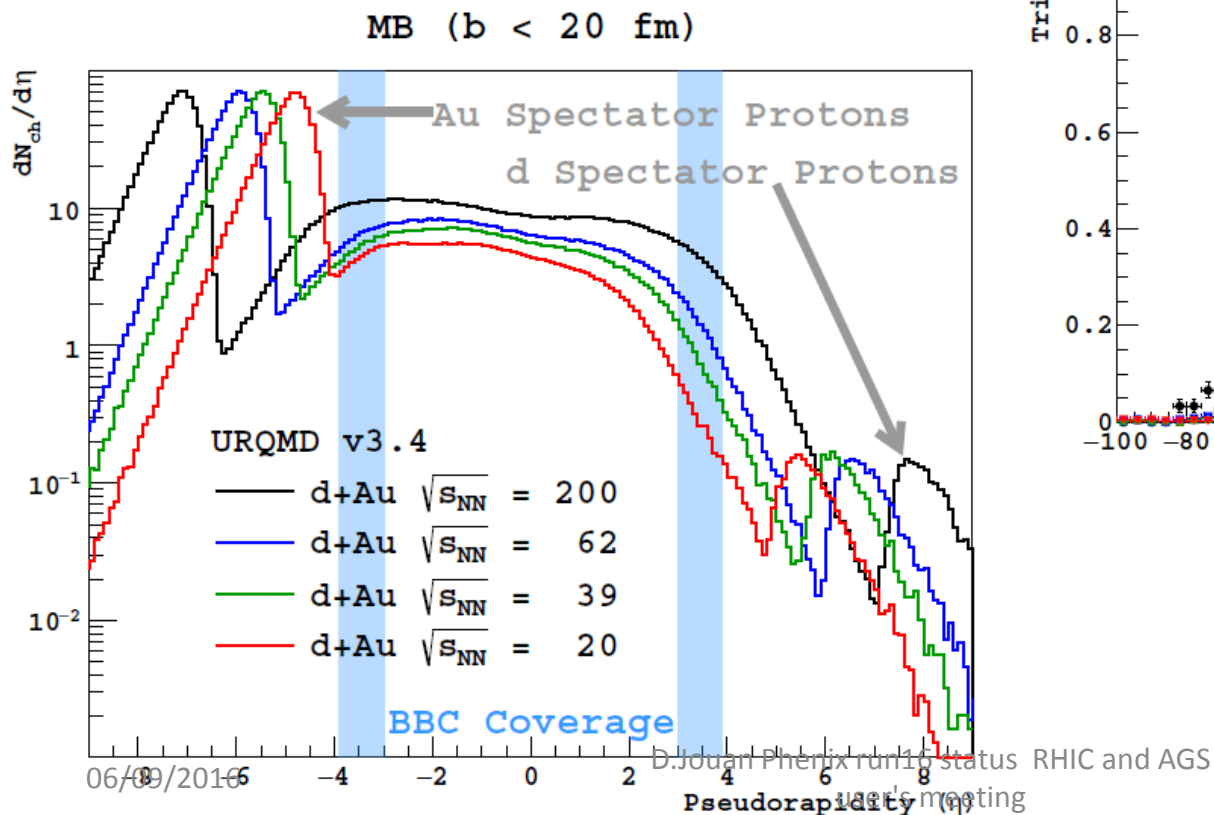
$1.2 < |\eta| < 2.7$

Sub-system commissioning/debugging

- Initial setup started from end 2015
- All detector subsystems installed, connected, and ready for commissioning beginning January
- Watch shifts started 12 January
- flammable gaz started the 14 January
- Full shifts started 26 January
- Data started 7 February (after blizzard)

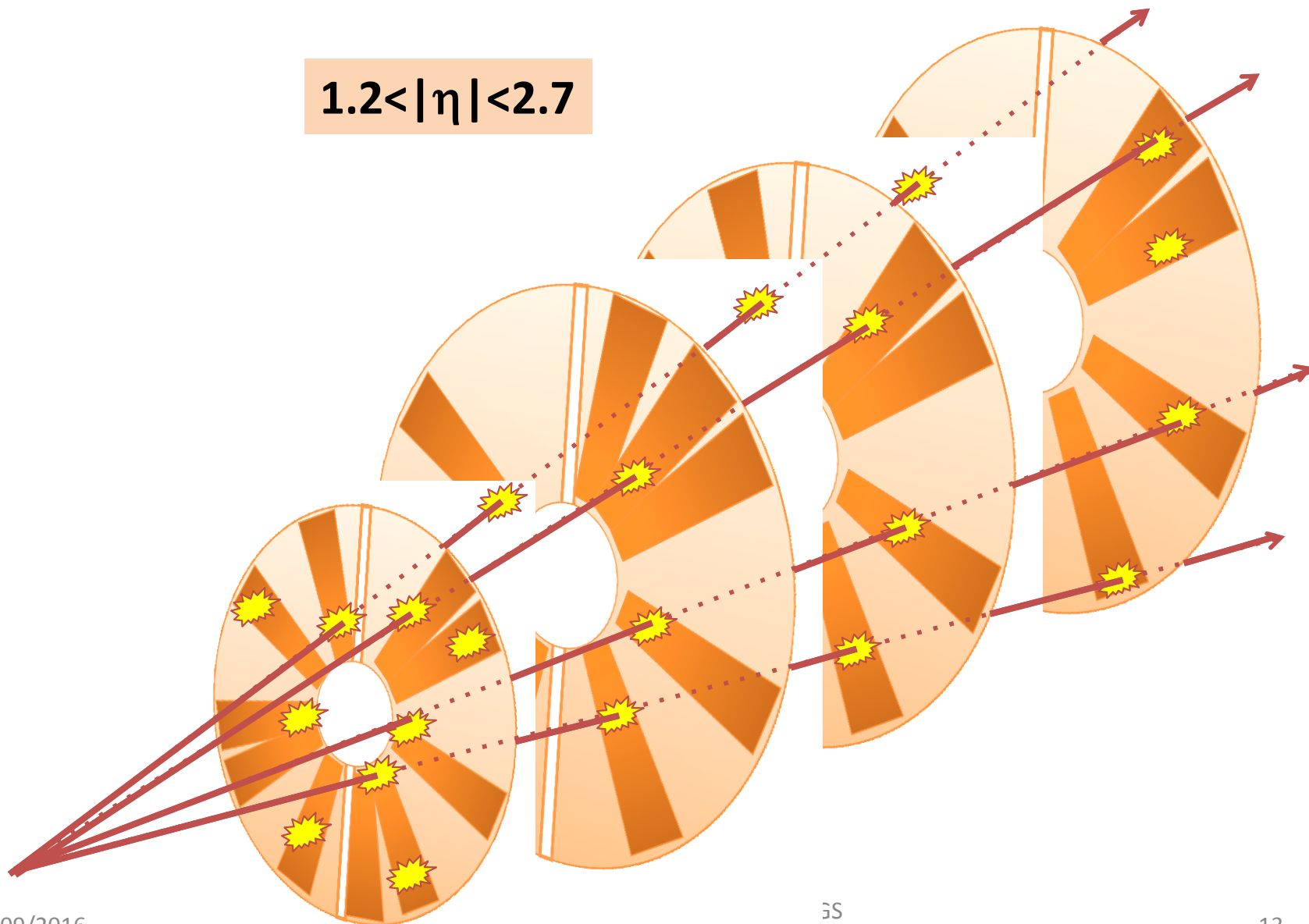
d-Au Low energy: a challenge for the BBC trigger

At low energy the multiplicity seen by the north (d) side is lower than 1



FVTX trigger: lower rapidity

$$1.2 < |\eta| < 2.7$$



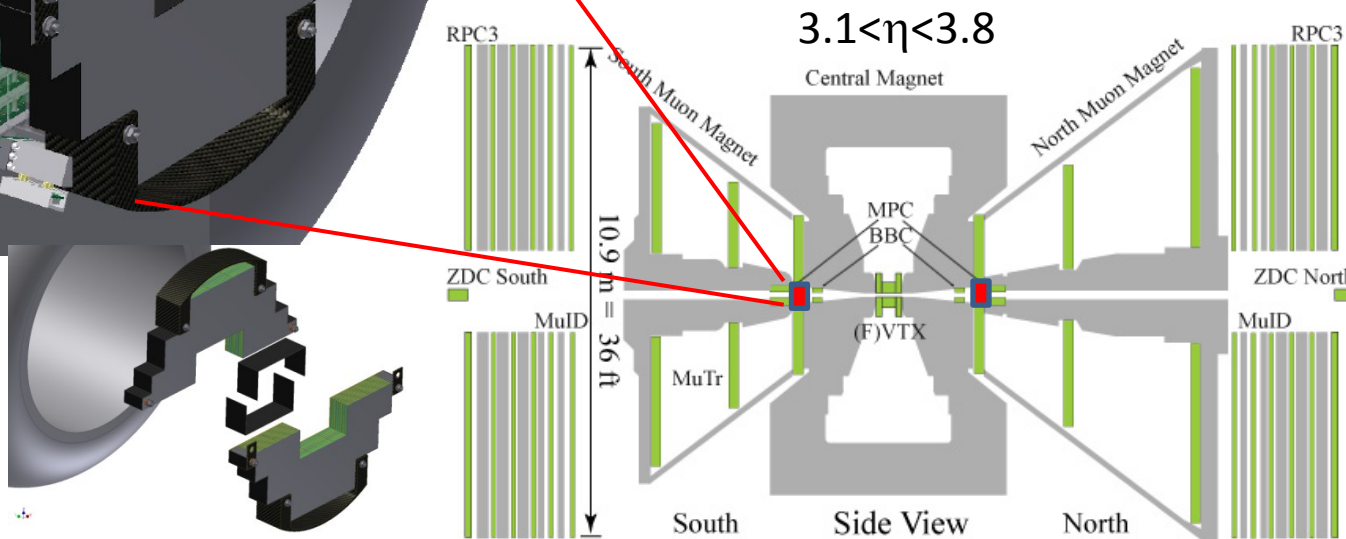
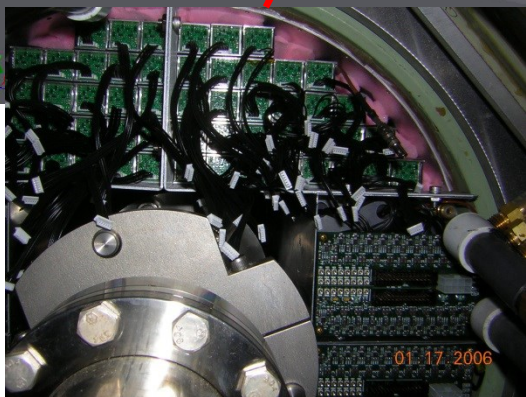
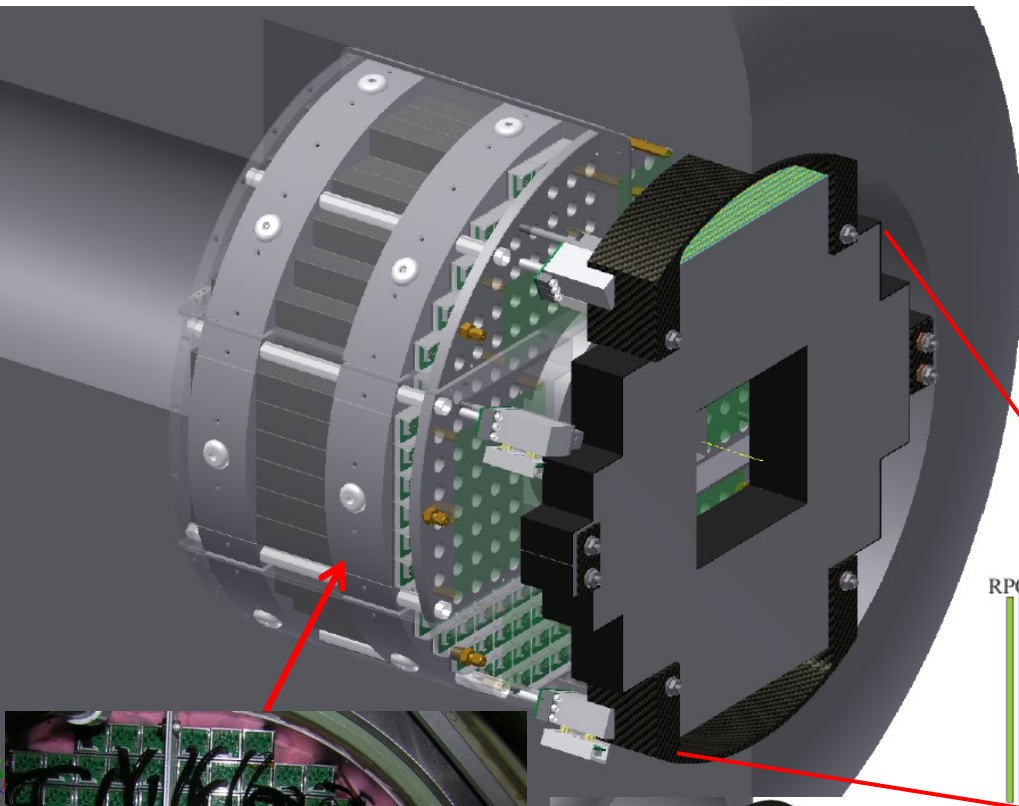
MPC EX: dAu 200 GeV

- MPCEX firmware upgrade, cooling improvement, low voltage distribution improved (radiation upsets)
- d-Au 200 GeV becomes first priority
- Change of the order of energies, 200 GeV first (prefires ?)

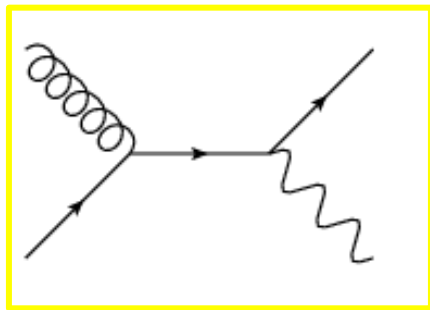
The MPC-EX Detector

A combined charged particle tracker and EM pre-shower detector – dual gain readout allows sensitivity to MIPs and full energy EM showers.

- π^0 rejection (direct photons)
- π^0 reconstruction out to $>80\text{GeV}$
- Charged track identification

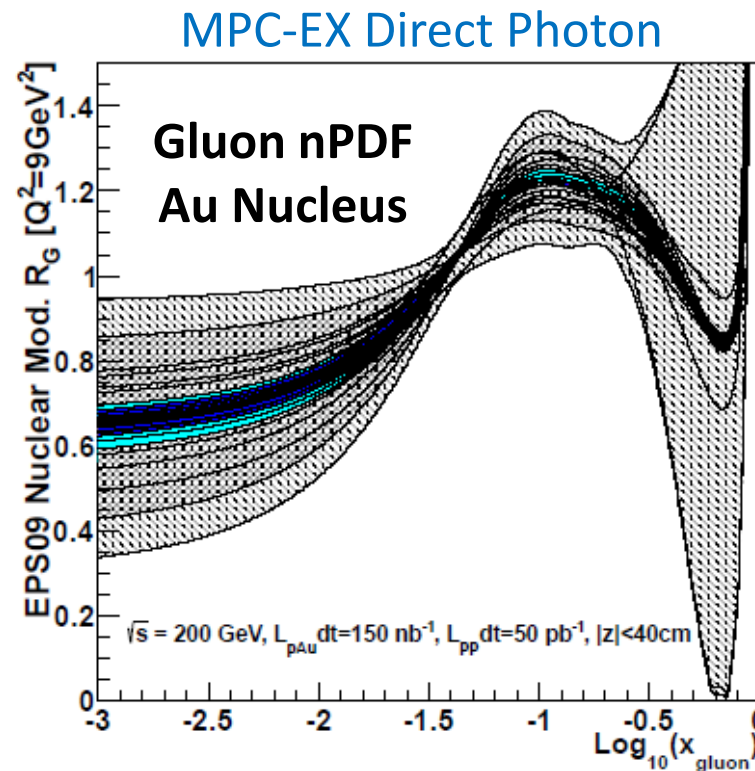


Constraining Gluon nPDFs



Thanks to **direct photons**
(no final interaction)

Measured by the MPC-EX & MPC
d side: low X Au

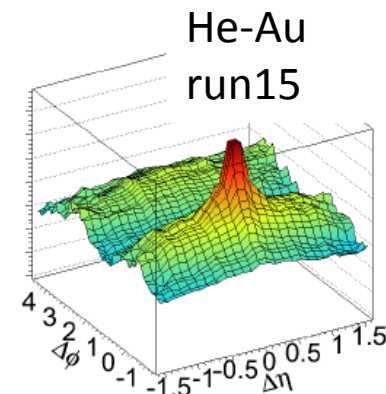


Dark blue: 1-sigma

Au-Au 200 GeV

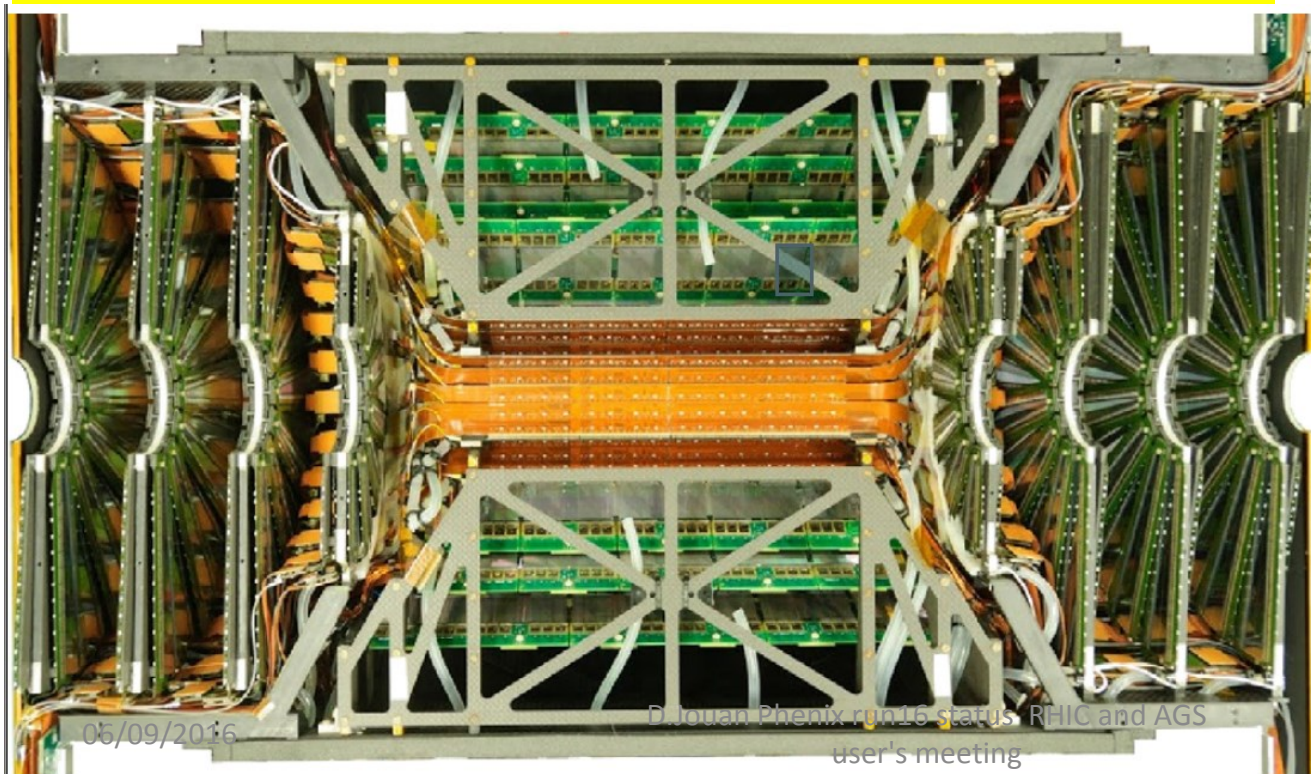
A very important requirement for PHENIX collisions : $|z| < 10\text{cm}$

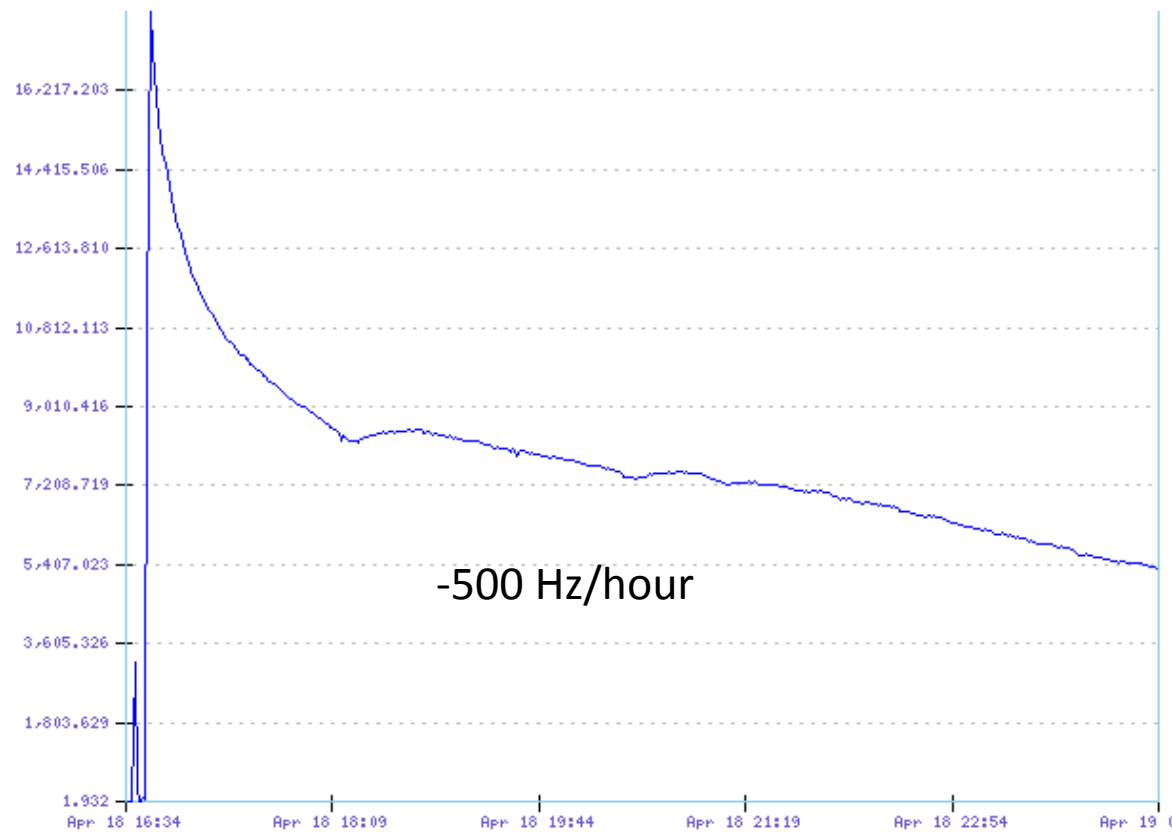
- In the $|Z| < 10\text{cm}$ vertex: **> 7KHz up to end of store**
 - + high average luminosity



The extended coverage brings new performances

Important also for the event plane



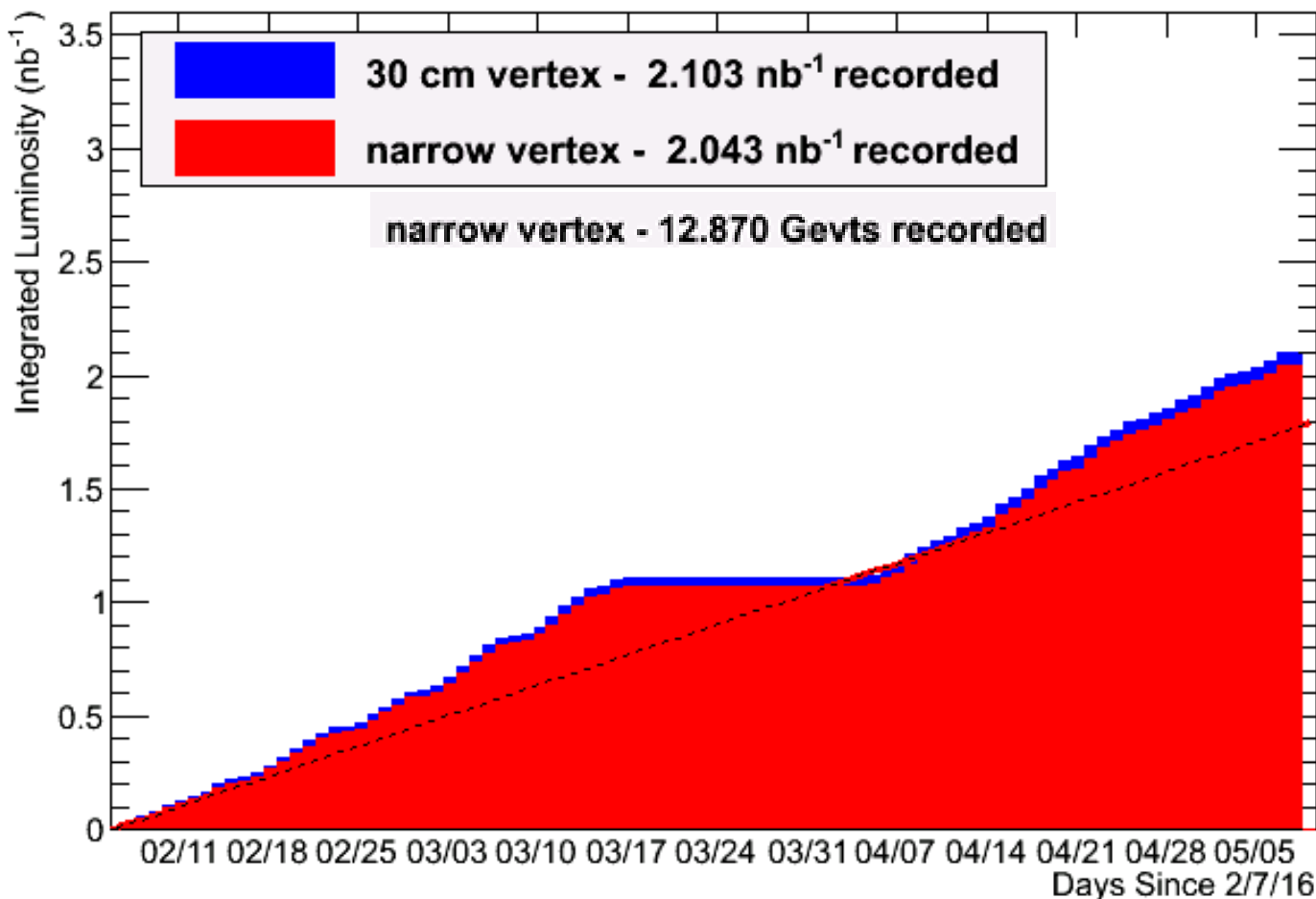


Beta star ?
 Leveling ?
 Stochastic cooling ?
 56MHz ?

Succeeding to keep the rate high : a « flat » store

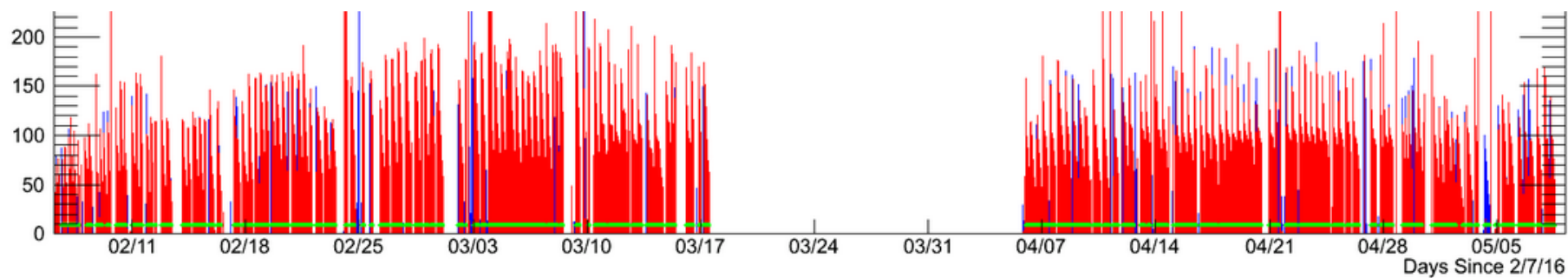
PHENIX Integr. Sampled Lumi vs Day

Mon May 9 09:01:23



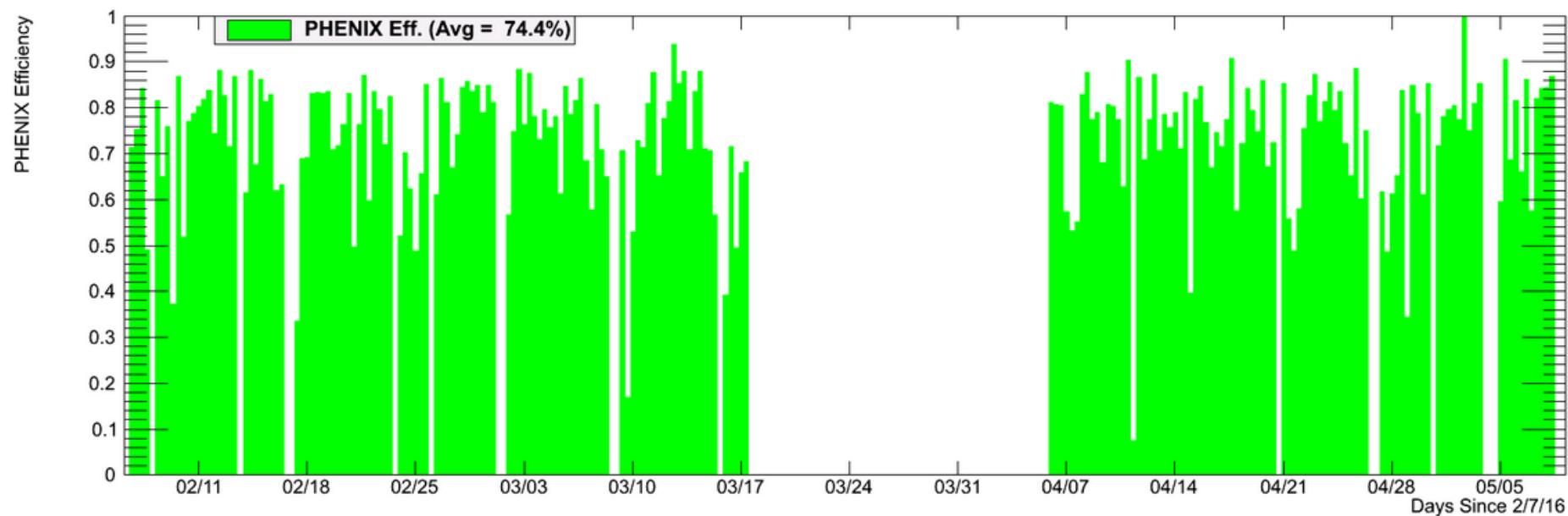
BUP goal
 1.8 nb^{-1}
 « narrow
 vertex, 5%
 central »
 Reached !

13% more
 luminosity



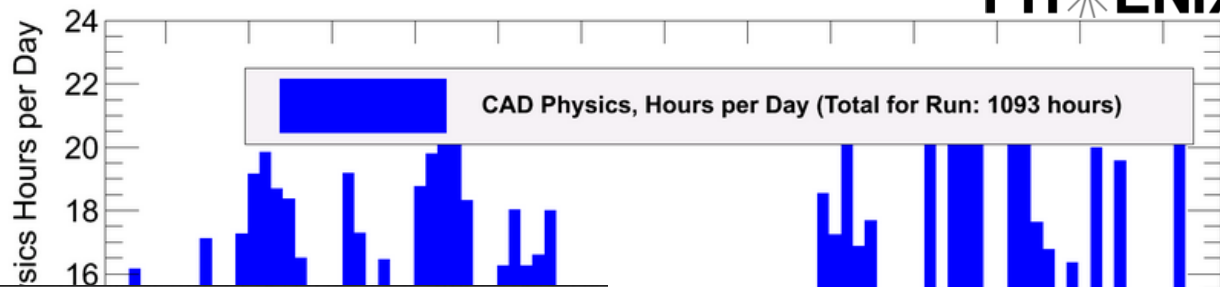
PHENIX Efficiency vs Day

Mon May 9

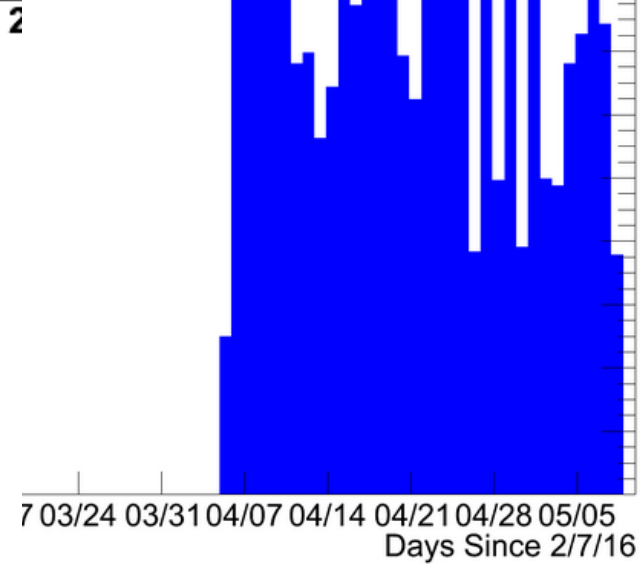
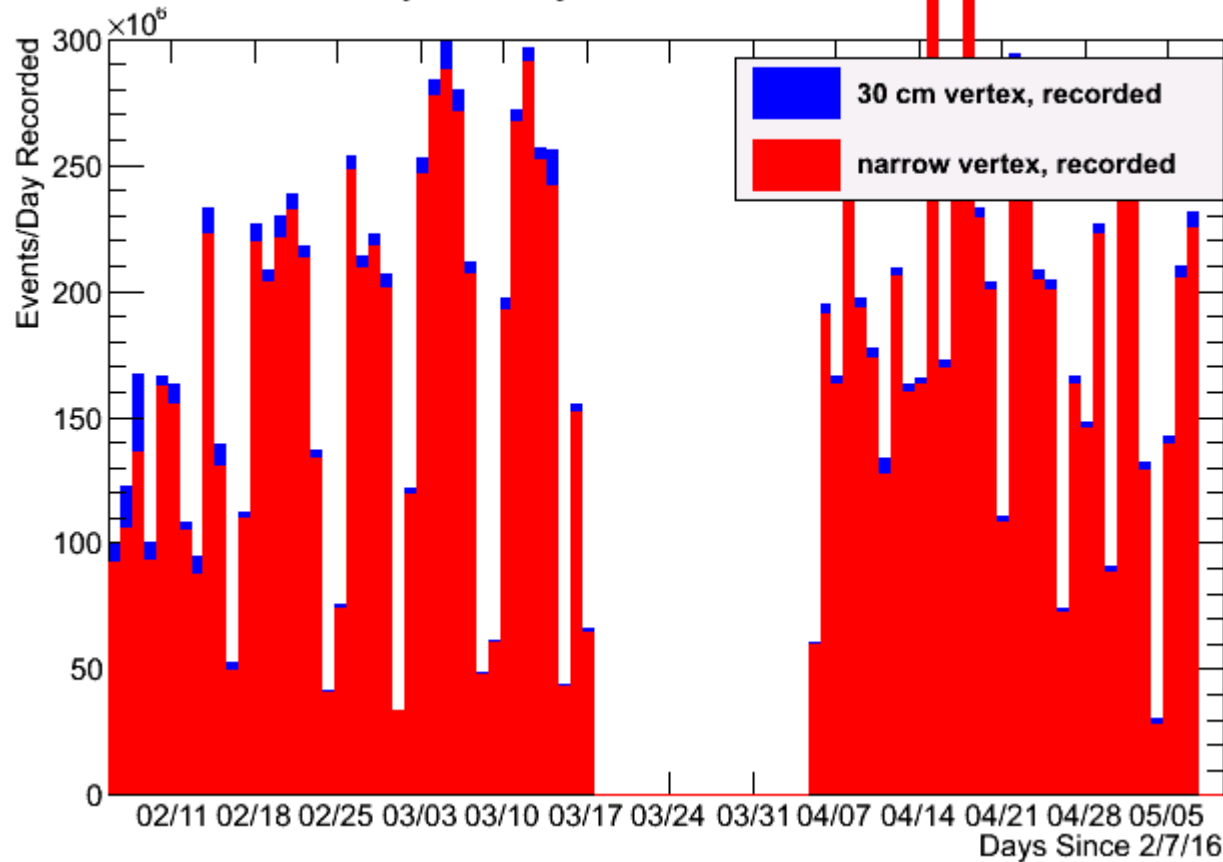


Regular data taking, good efficiency

CAD Physics Hrs/Day vs Day



PHENIX Events/Day vs Day



- BUP goal has been reached
- and even beyond: 13% more
- Very successful AuAu run,
- With high narrow-vertex rate delivered along almost the entire store
- 2 last days of AuAu used to repair of the drift chamber (20% acceptance) thanks to a maintenance (Mon)day

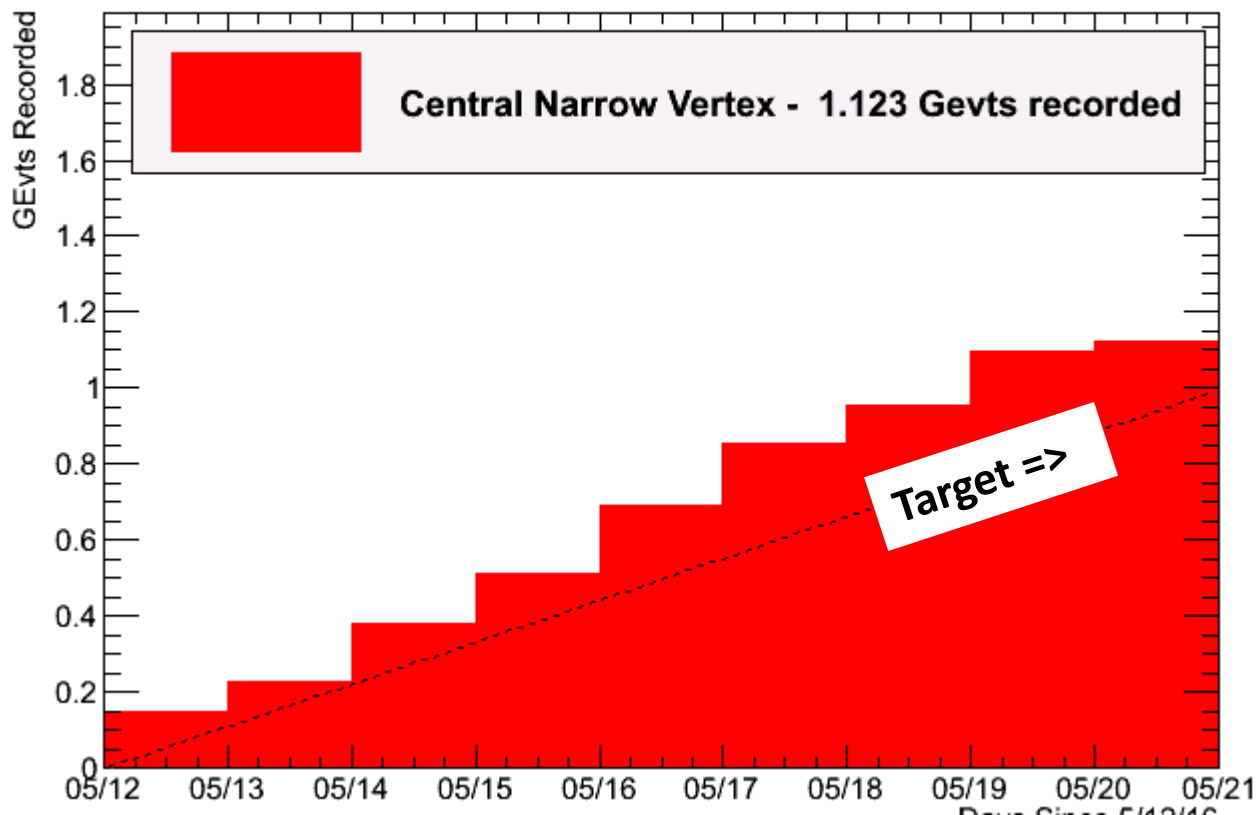
d-Au strategy

- 200 GeV became a priority thanks to an additional target : using the MPC EX to measure gluon nPDF.
- -> New sequence : 200, 64, 20, 39
- -> at 200 GeV two triggers: « min bias » (central and $Z < 10\text{cm}$) and MPC (high P_t particles), one is driven by the recorded event rate, the other one is driven by the delivered luminosity

d-Au 200: very successful

PHENIX GEvts vs Day

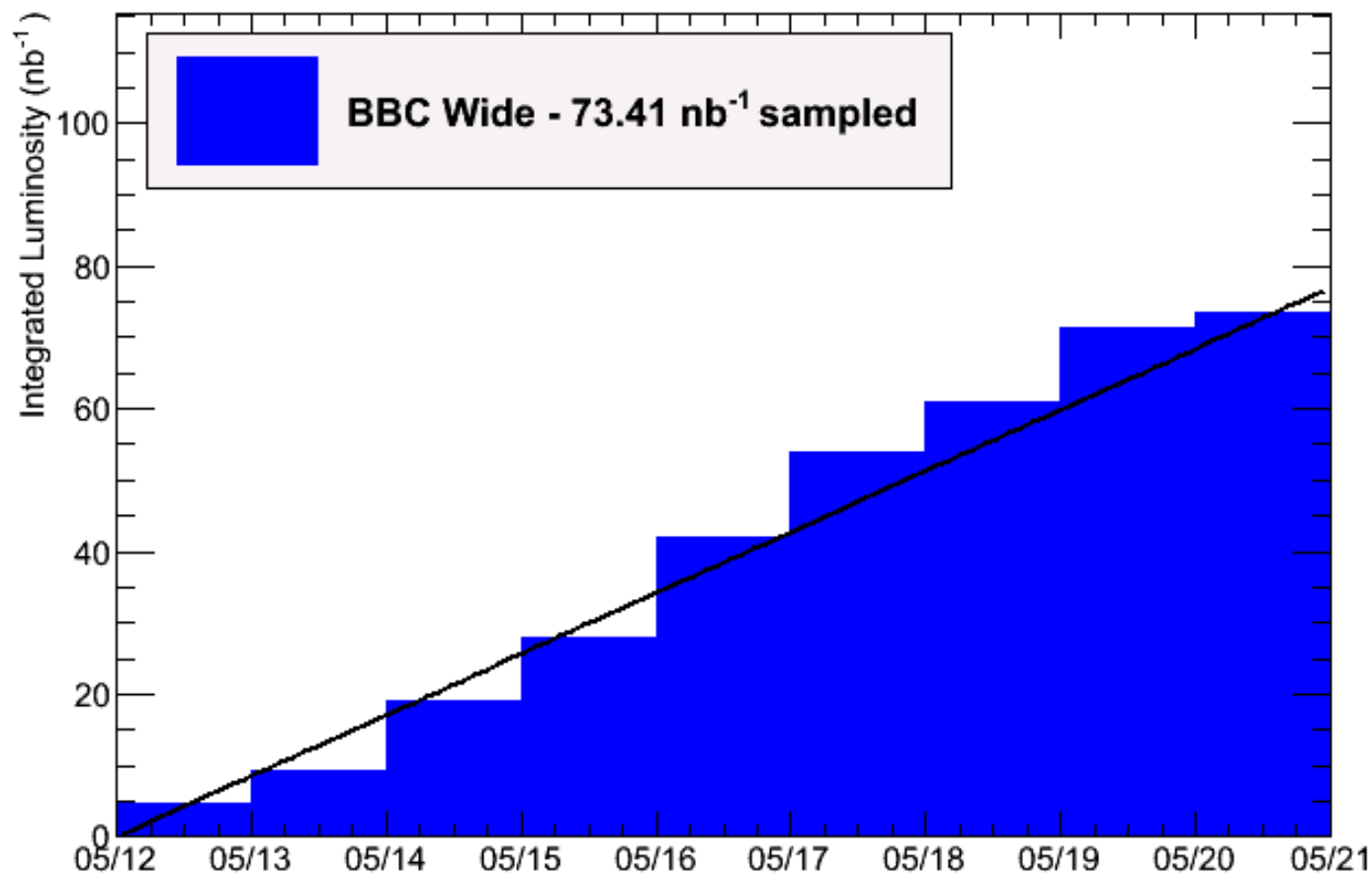
Fri May 20 09:00:14 2



For the
Minimum bias
(=all collisions)
trigger *inside*
ZV<10cm and
5% centrality:
Recorded
number of
events
(updated goal:
1 Billion
events)

MPC trigger: live luminosity

PHENIX Integr. Sampled Lumi. vs Day Fri May 20 09:00:13 2



A successful collective effort to go beyond the limits, but some final downtimes....

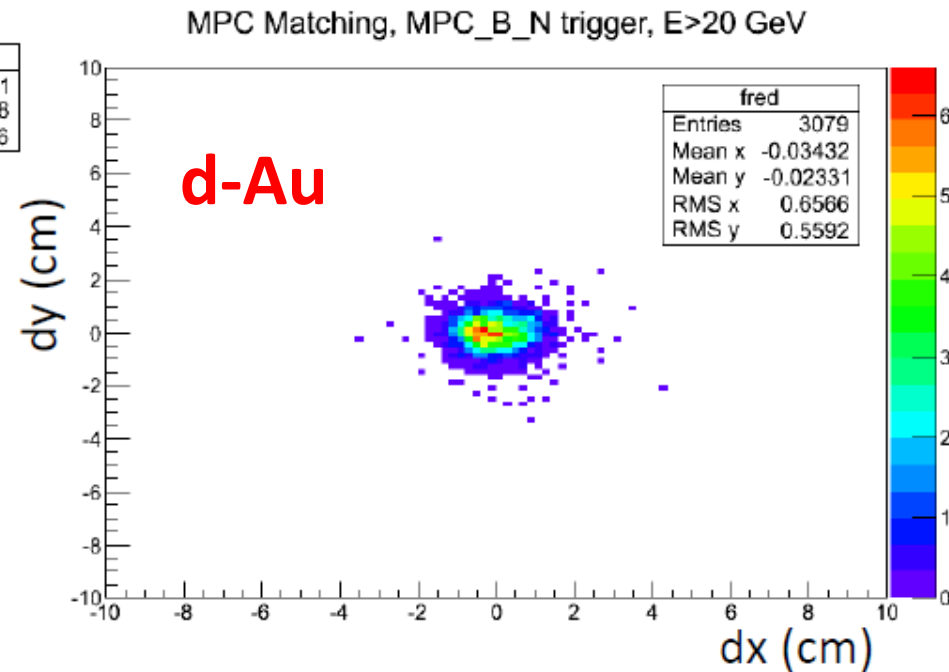
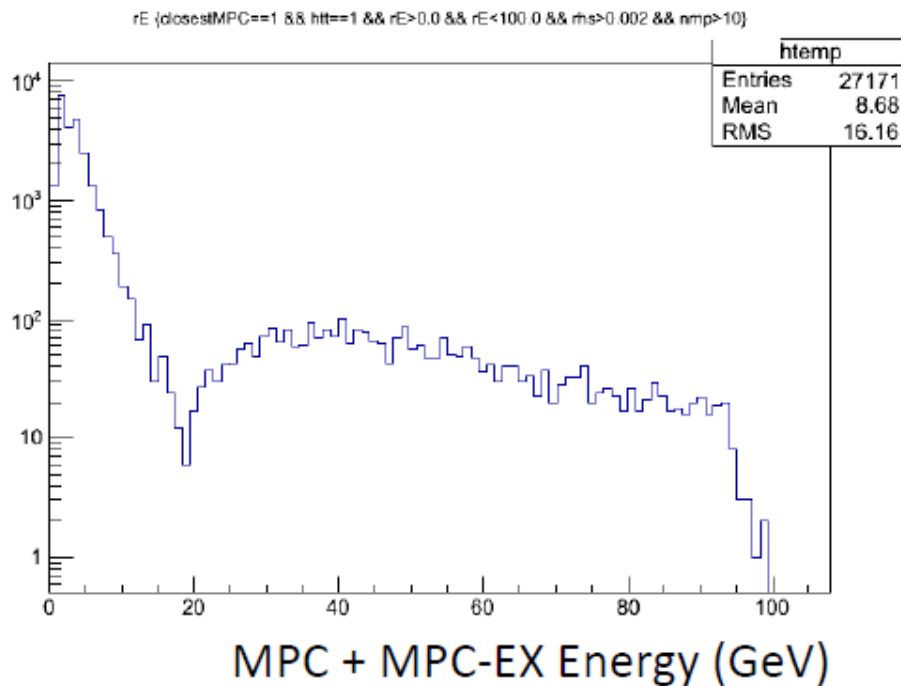
« Compatible with the error bars »

Or: 5% at the end, is only 5%

Good timing :

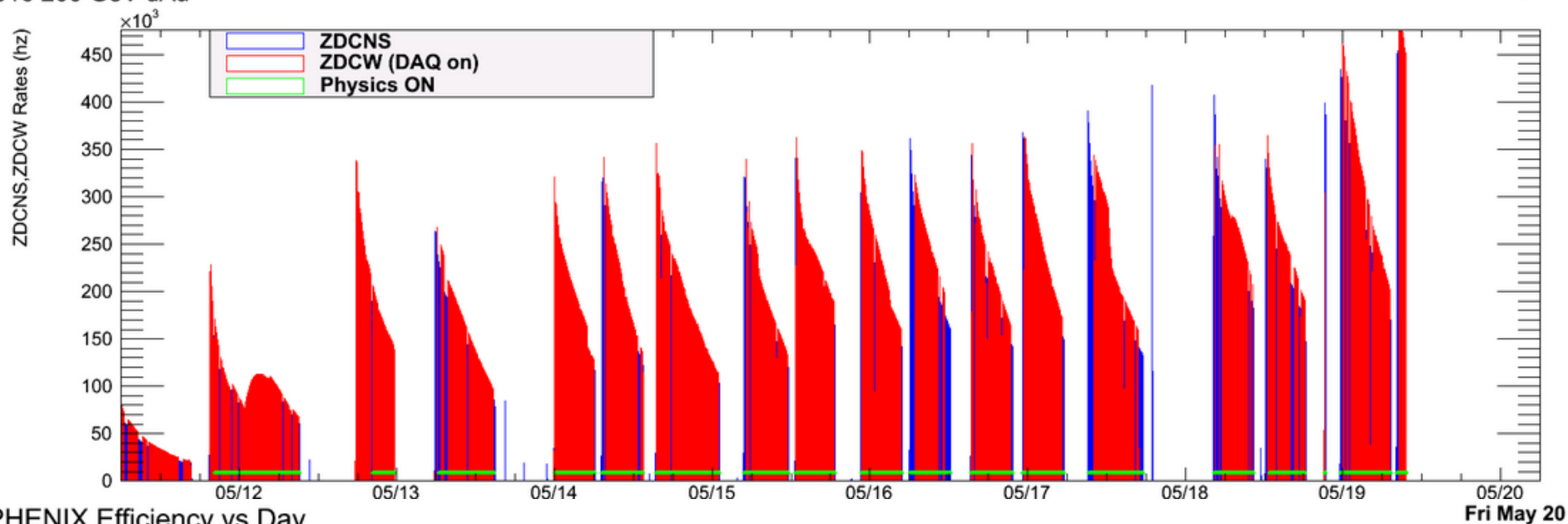
clear correlation MPC-MPCEX

Physics runs, MPC_B_N trigger.

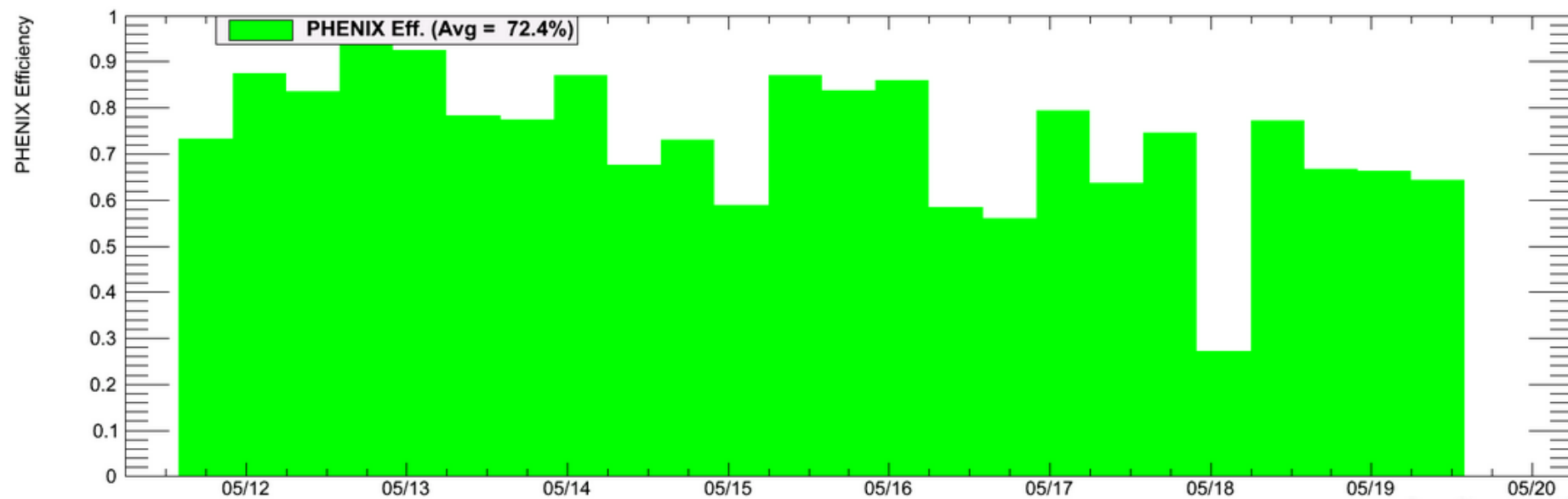


- MPC-EX Shower Cuts:
 - MPC-EX shower RMS (Hough space) > 0.002
 - Number of minipads in shower > 10
- Tight correlation for high energy showers (fire MPC_B_N trigger)

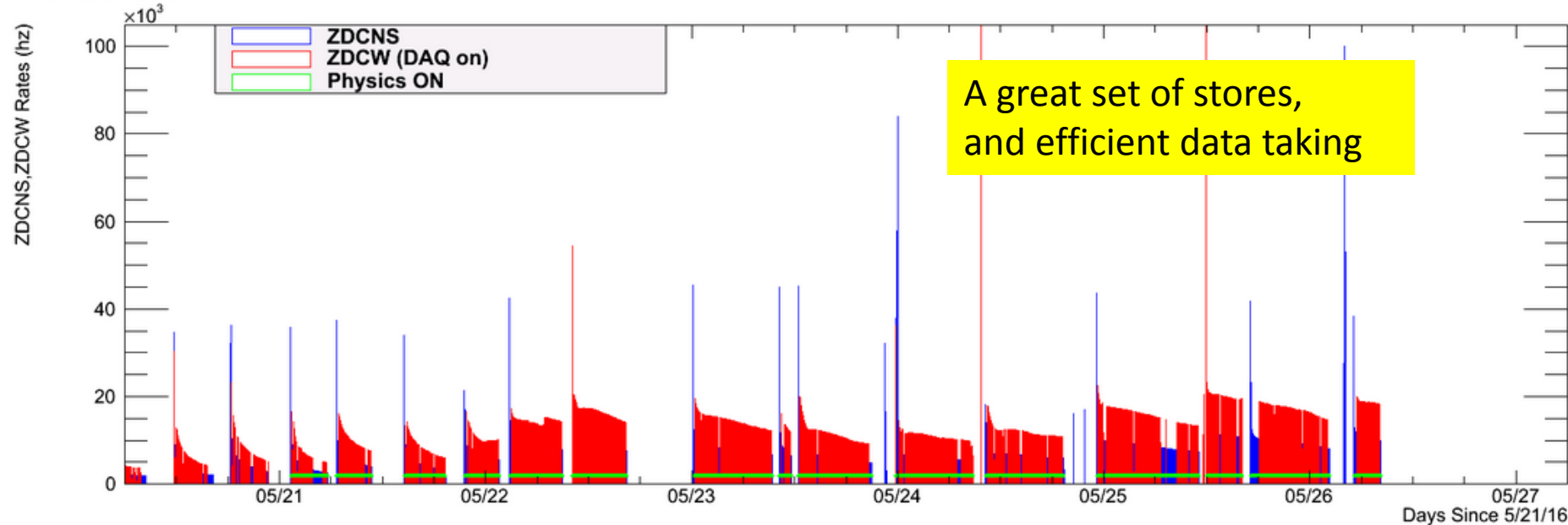
2016 200 GeV dAu



PHENIX Efficiency vs Day

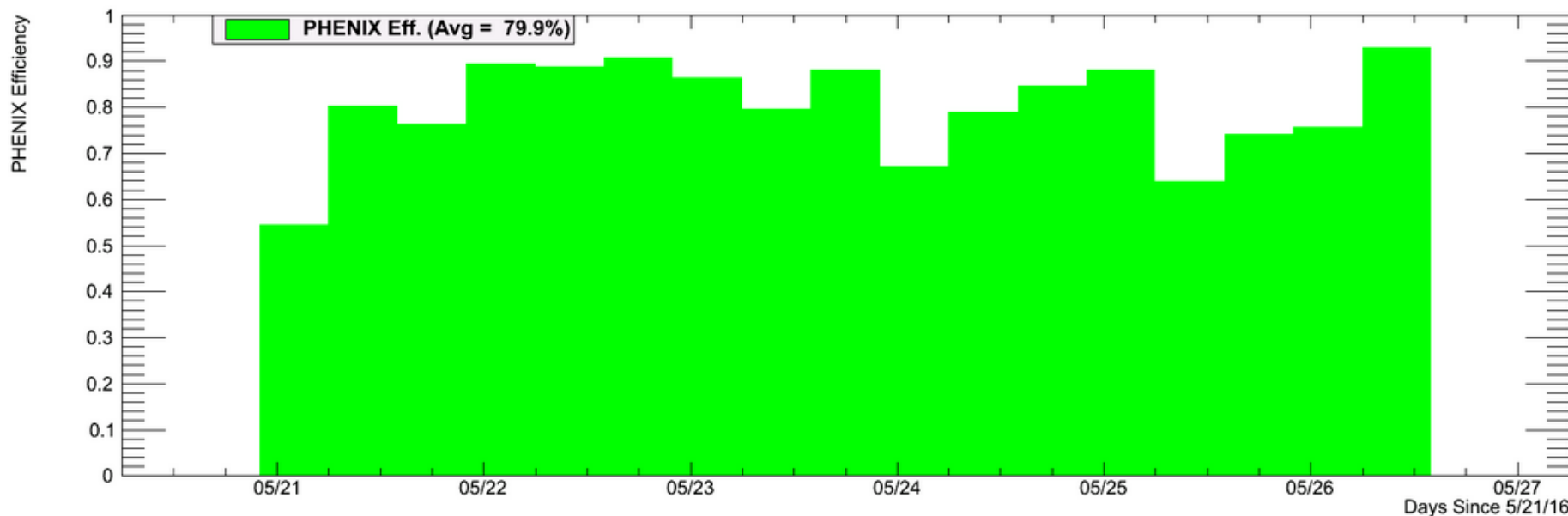


62 GeV

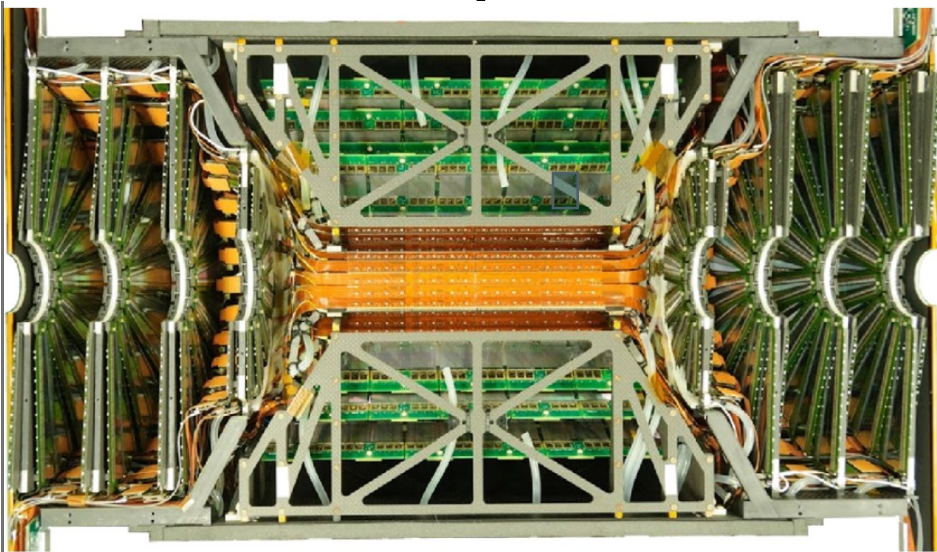


PHENIX Efficiency vs Day

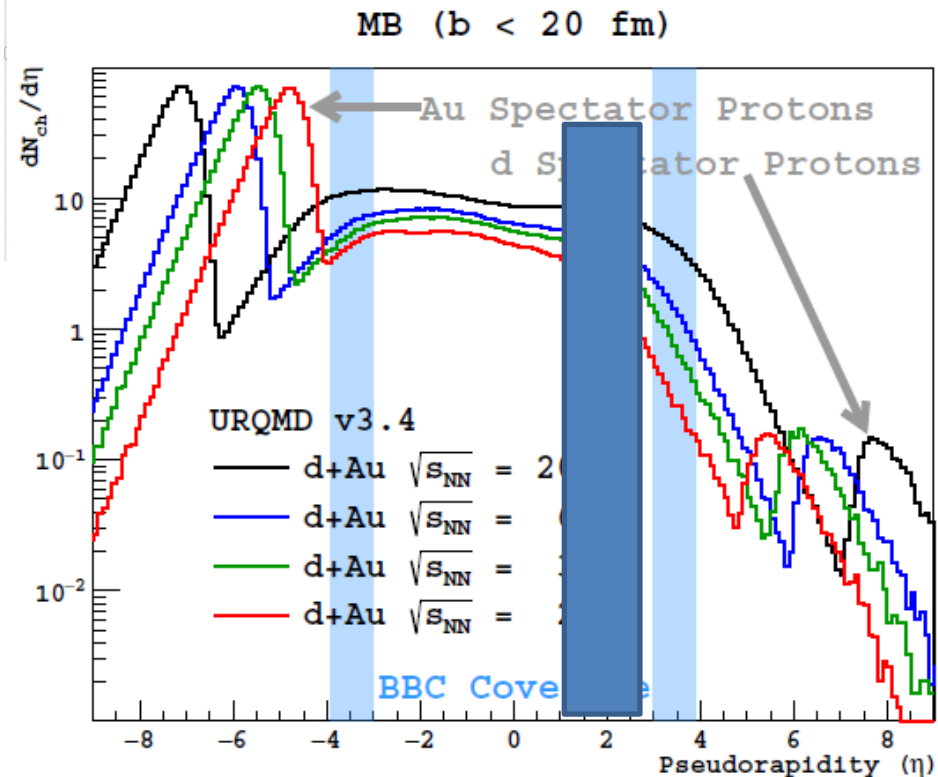
Fri May 27



Also a good point to check and compare BBC and FVTX triggers



FVTX (1.2-2.4 eta) at 20 GeV
sees a higher multiplicity than
BBC



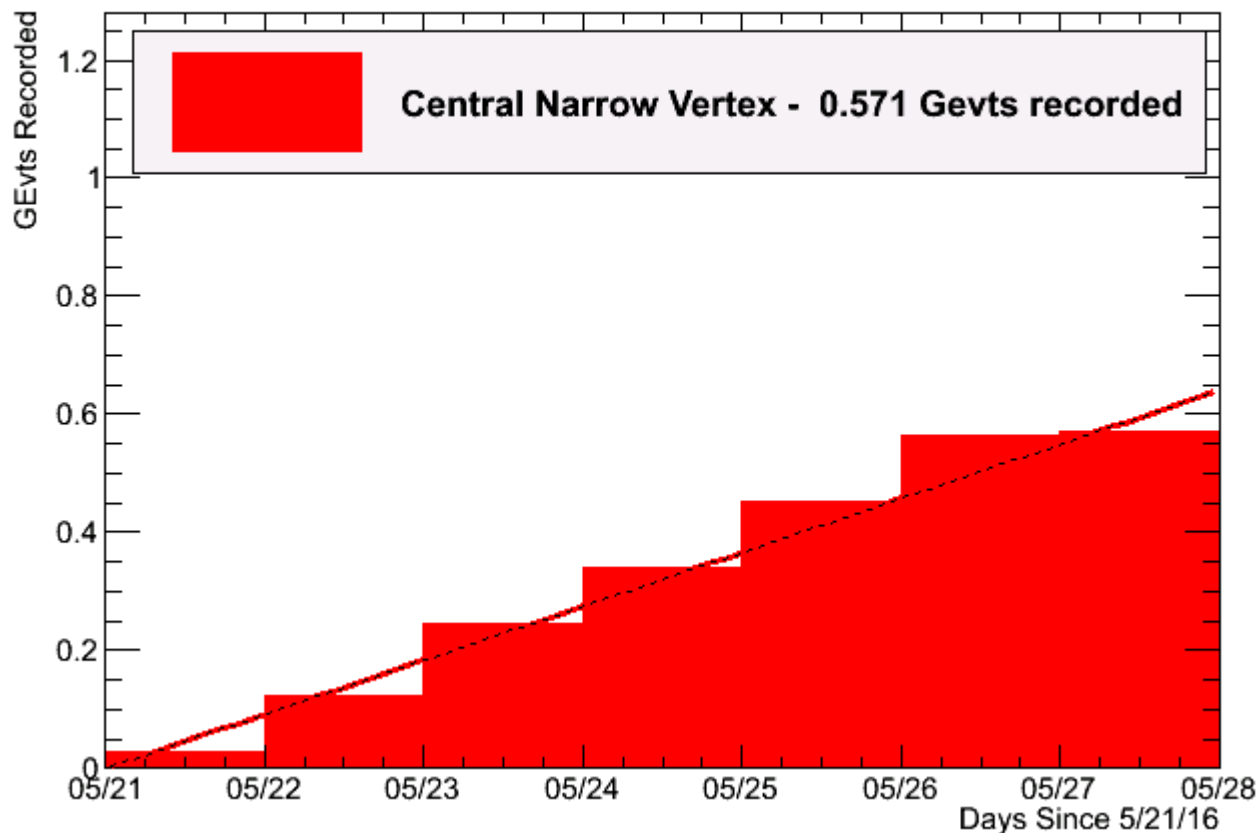
It was going so well, why had it to be cut short ?

- Friday 27 may, 2-3 in the morning, a sequence of alarms led to the complete shutdown of the power and gaz in the detector, and release of inert gaz.
- Only 17 hours later, after BNL teams (safety, fire, cas, cad, phenix, ...) solved all issues and changed the air in the IR (some kind of « invisible pollution-like smoke » was still tripping sensors), the detector was on again (except TOF and DC-PC)
- DC-PC and TOFW back in from Monday night.

d-Au 62: very successful beam and data taking

PHENIX GEvts vs Day

Fri May 27 06:00:11 2016



For the Minimum bias (=all collisions) trigger *inside* ZV<10cm and 10% centrality:
Recorded number of events

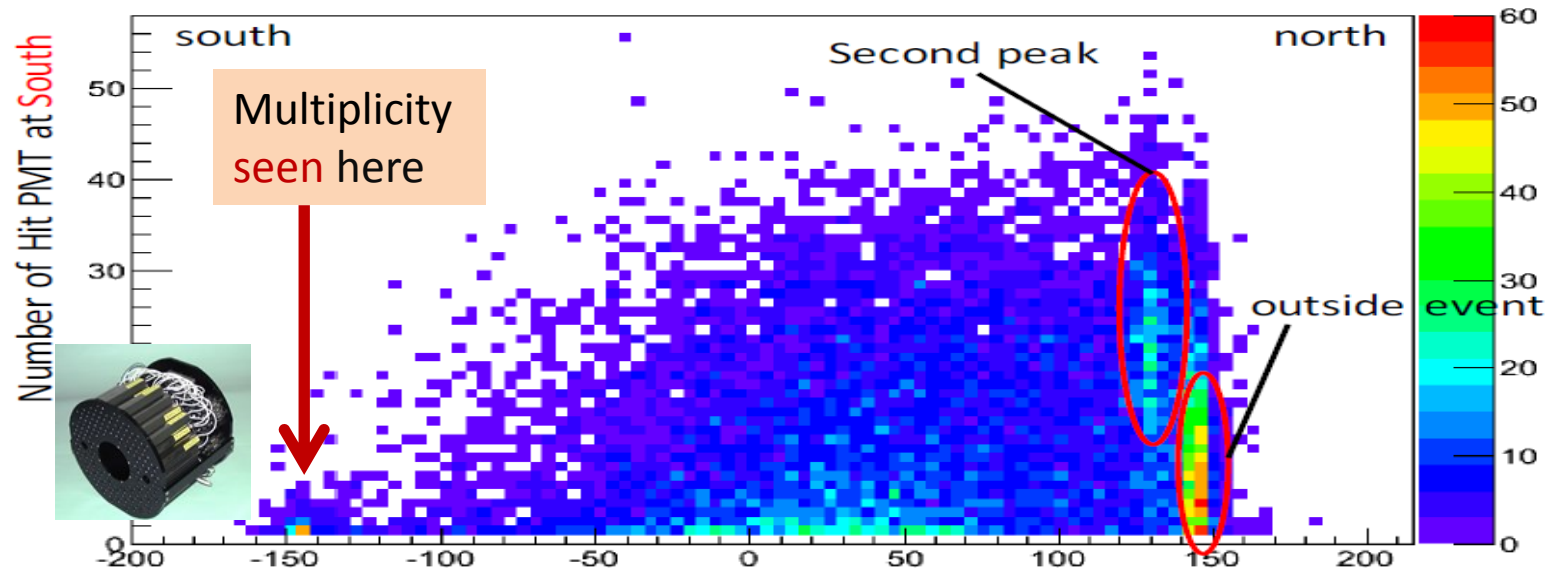
-> **280 Million** 5% most central collisions and ZV<10cm

BUJ goal: **230M**
Updated: **160-320**

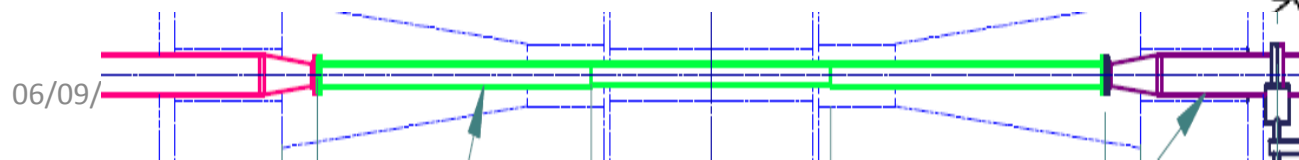
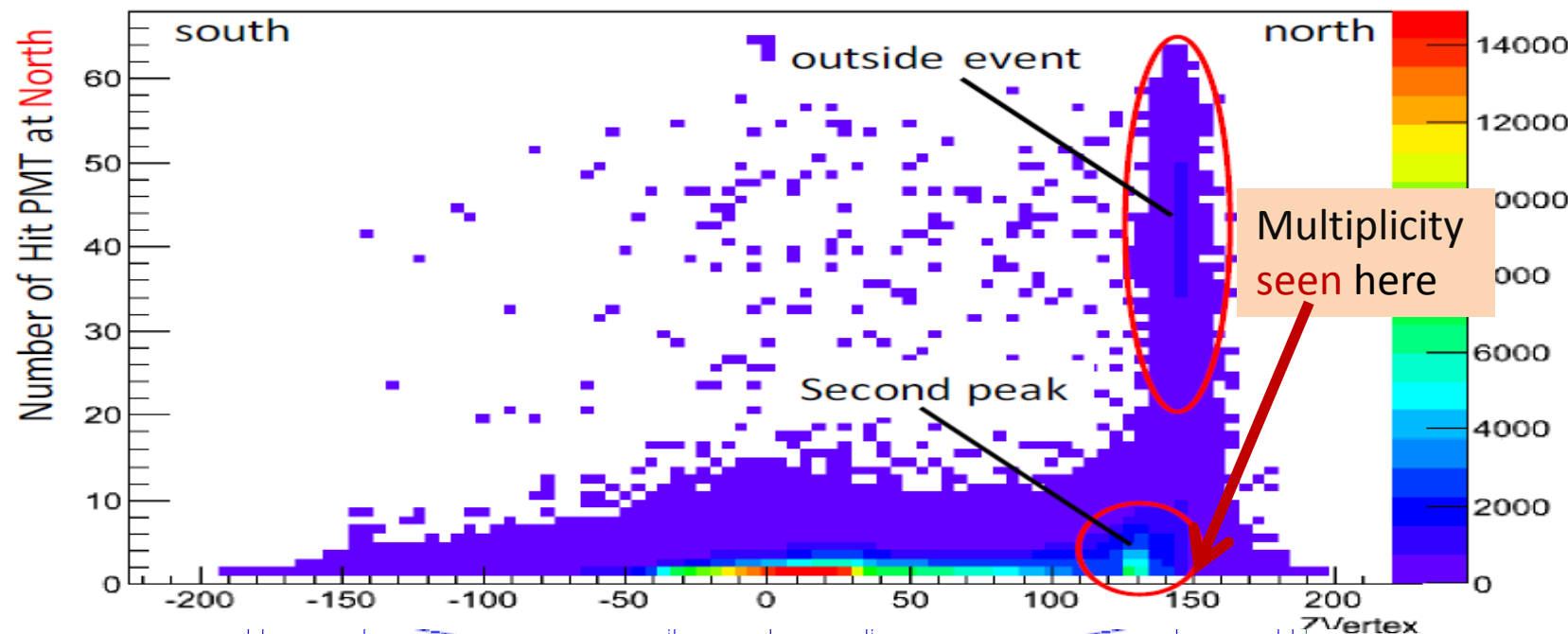
d-Au 20 GeV

in another kind of smog

- Very difficult start
- Meaning of trigger rates unclear, lots of fluctuations, background effects
- Quick offline analyses needed to determine fraction rate of good events
- Global timing problem discovered late
- Continuous but slow improvement
- But finally



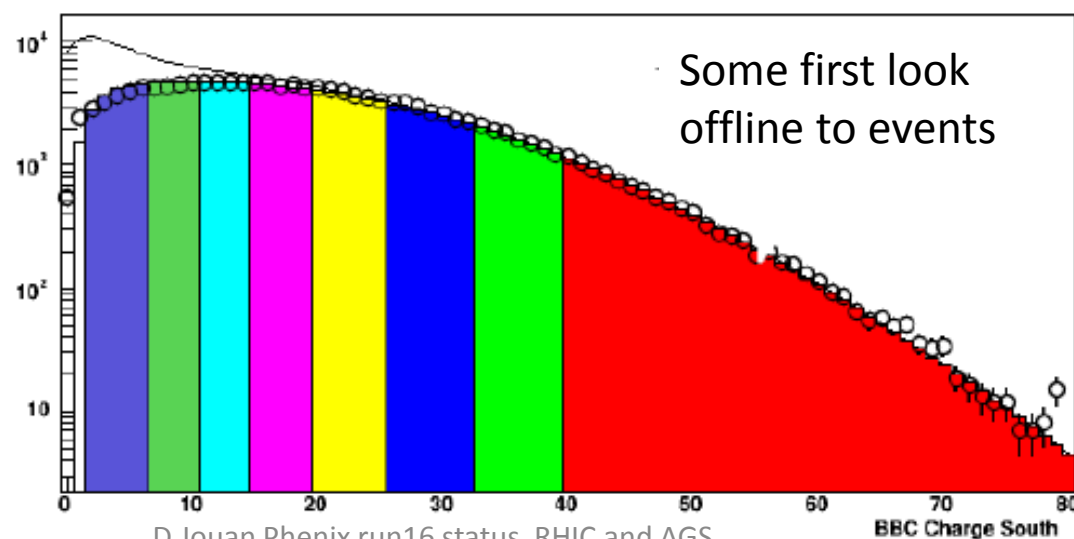
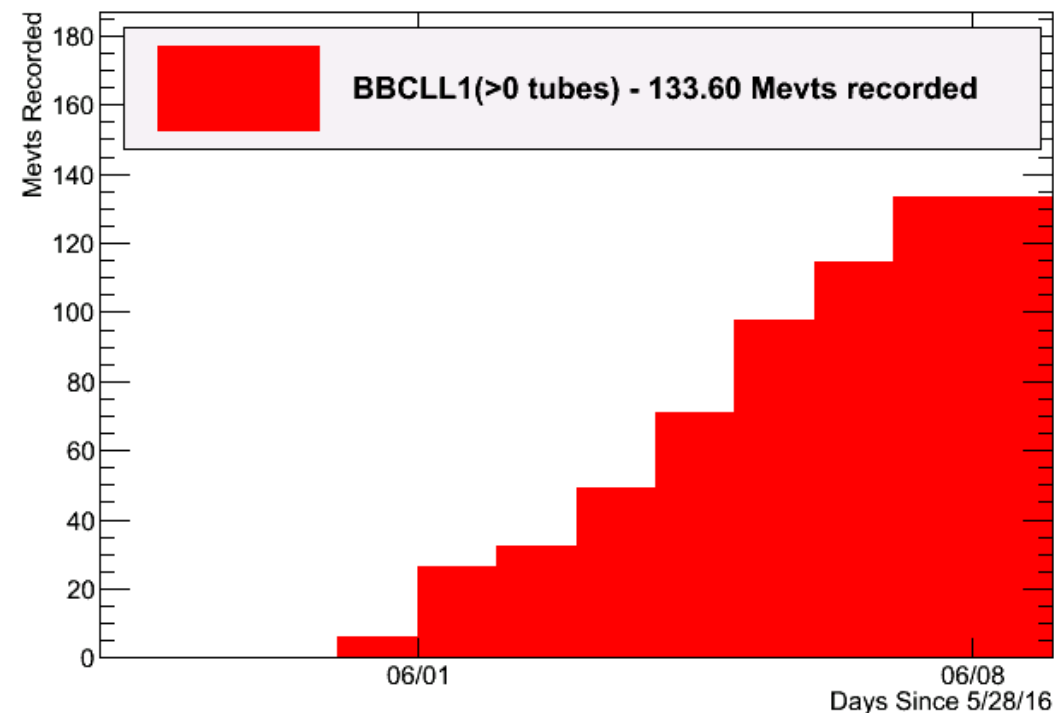
The peak at 130cm is probably a collision with North flange (high multiplicity in south)

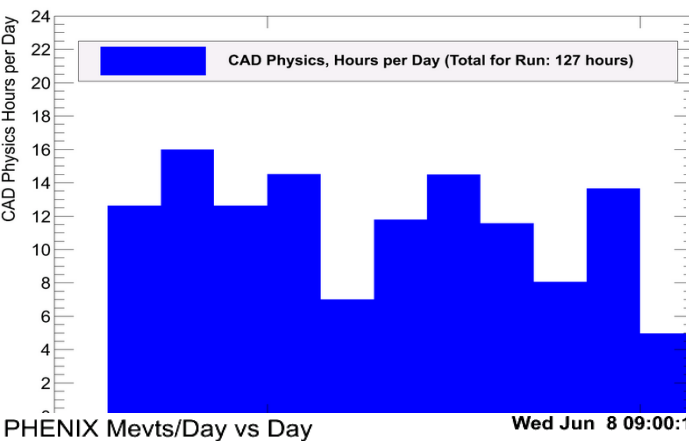


dAu 20 Gev

After offline reconstruction, it is likely that the number of 5% most central events with $Z_{\text{vertex}} < 10\text{cm}$ Be at least 7.8 M events

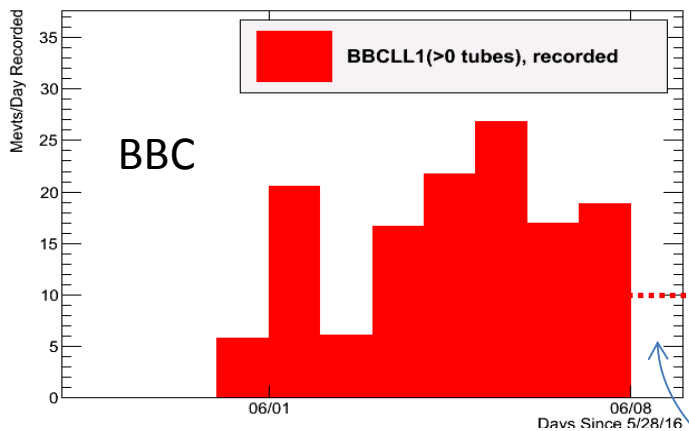
Between the 7M BUP goal and the 9M « updated » goal





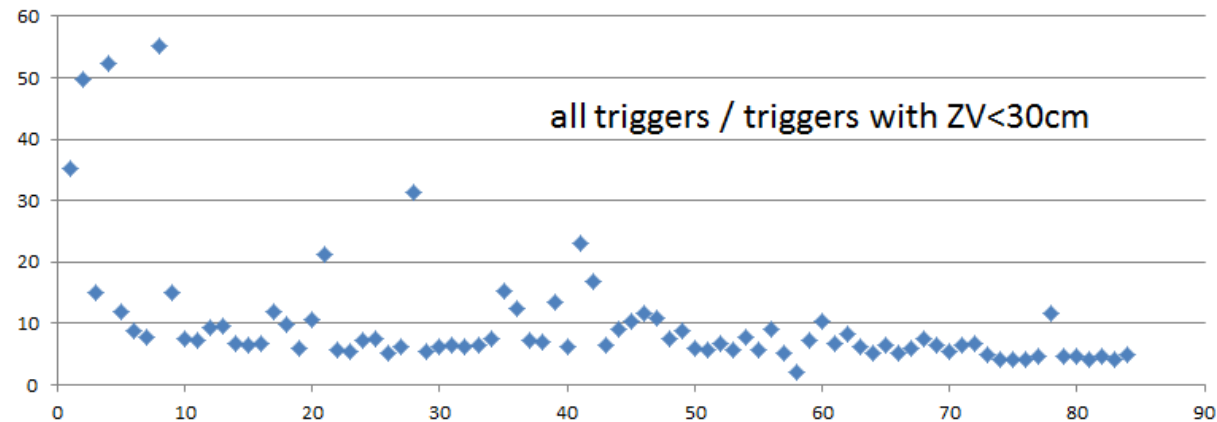
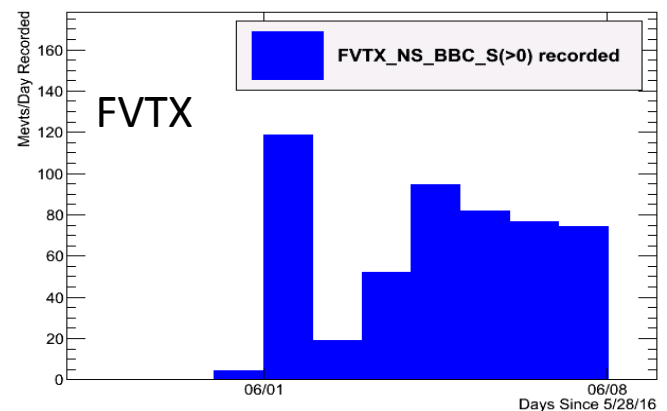
PHENIX Mevts/Day vs Day

Wed Jun 8 09:00:1



PHENIX Mevts/Day vs Day

Wed Jun 8 09:00:1



Evolution with time toward more consistency (wide triggers more sensitive to backgrounds)

By the way: loss of memory due to power dip ?
→ **Total 8.6 M !?**

Great data set ! Going to Wednesday morning was very fruitful

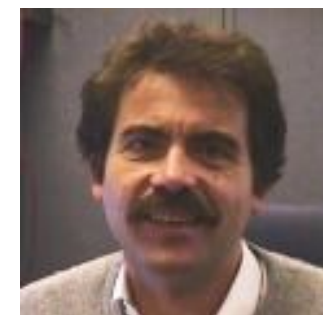
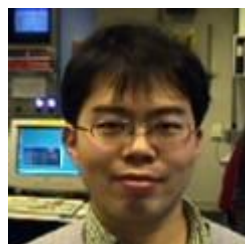
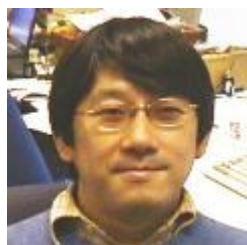
dAu 20 GeV was a challenge, it was difficult and started slowly, but improved a lot through time. It was very useful to give it enough time. The result is going beyond the BUP goal . 11 days after its start, it is finally a big success !

Next steps

- 39 GeV dAu > 17 june
- 200 GeV AuAu end of run

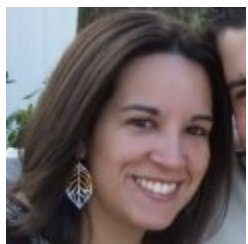
Thanks to all shifters !!

Special thanks to the owl shifters !! (in phenix, 0-8AM)





Thanks to the period coordinators

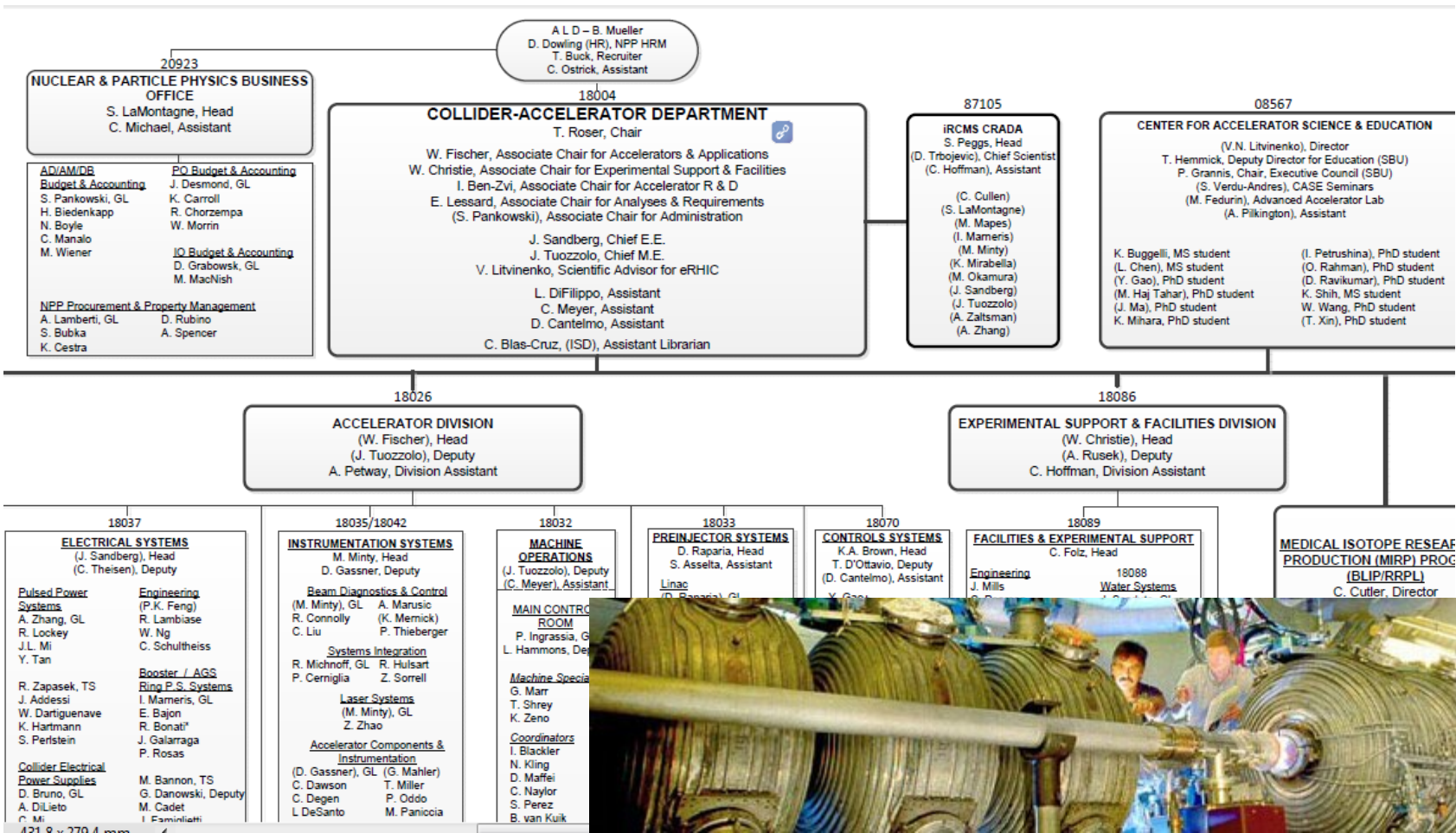


This year a deliberate attempt to include

- more women
- favor first experiences

Thanks to BNL, CAD, RHIC

- great beams , great collection of data, goals fulfilled
- Thanks to all the services and in particular CAD



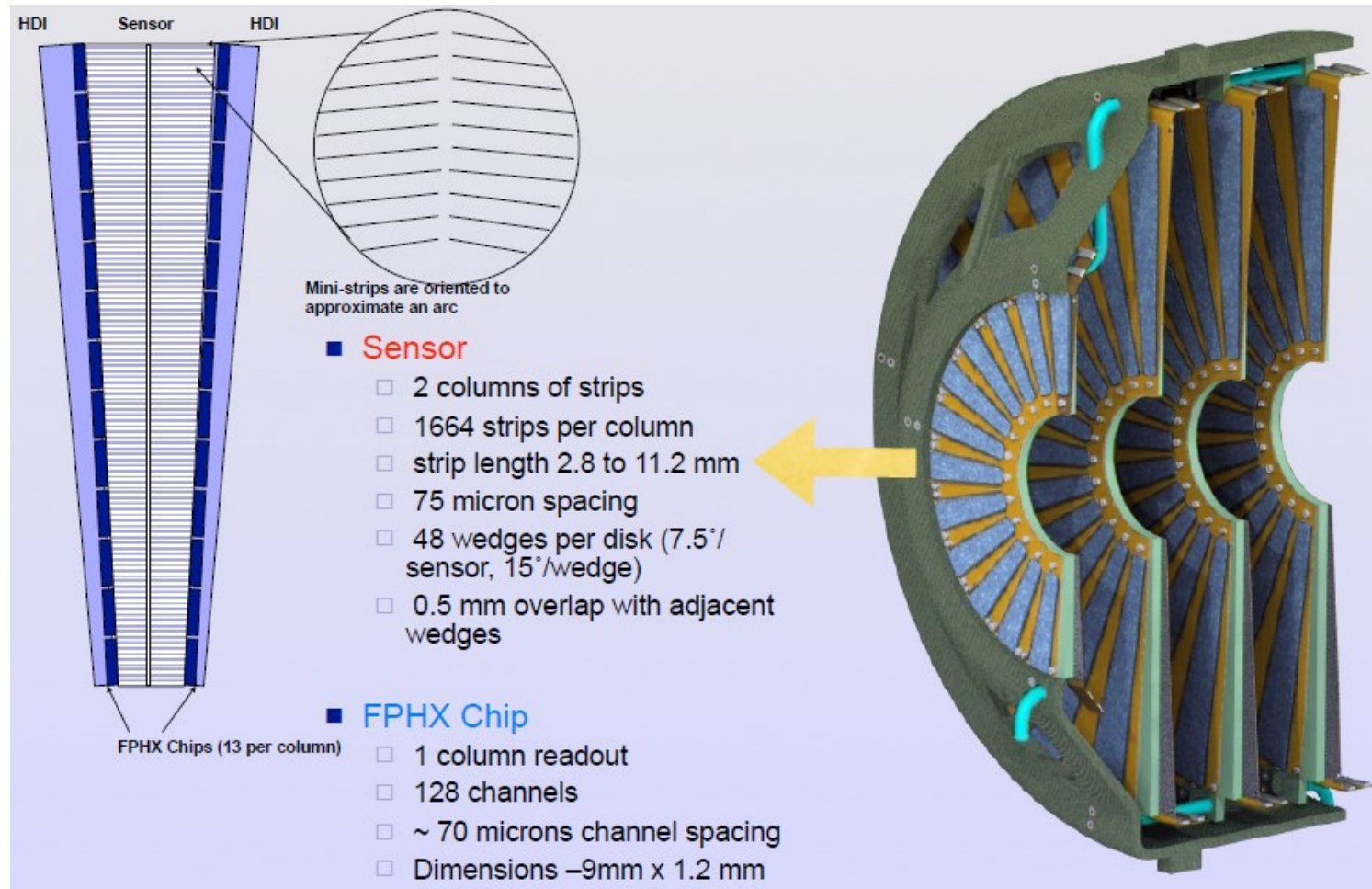
A great adventure, a great job, a great outcome , for a great purpose, in a great place

- It was like a novel
 - Dramatic magnet
 - Passion, action, politics, money, thrill, questions, answers, technology, science
 - hundreds of participants playing in the same place, a music of bunches of particles with giant instrument
 - Like an entire city aiming at only one goal
- (OK maybe sometimes two, star and phenix)

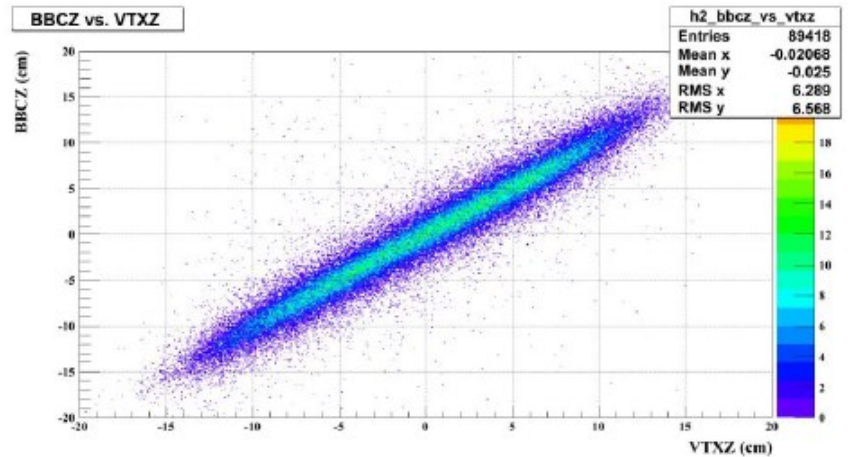
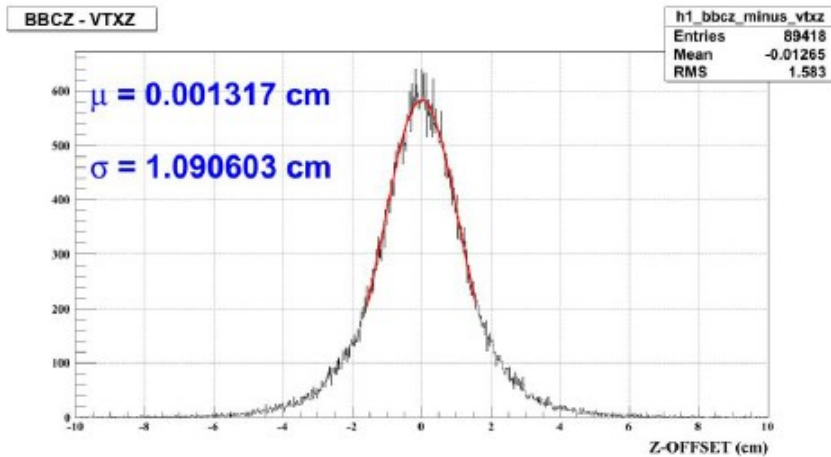
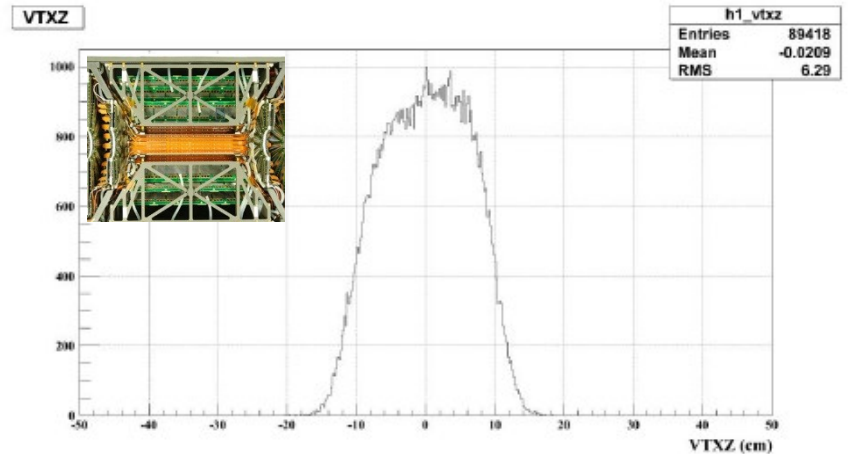
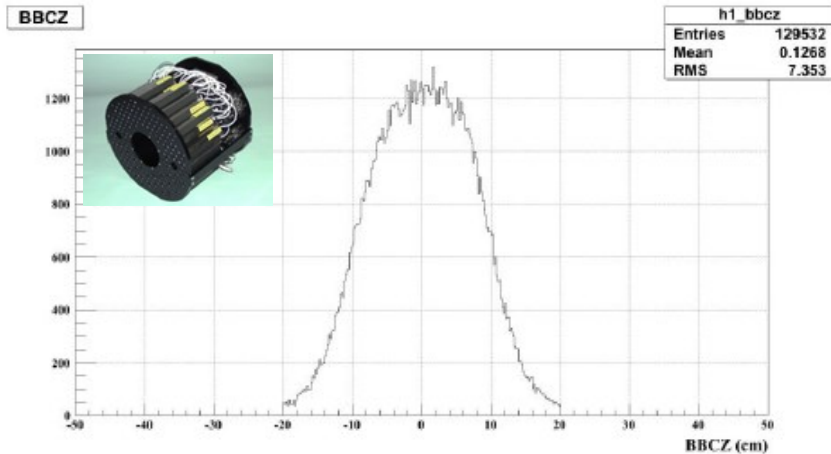
Summary

- Evolutive planning all along, plus one catastrophic event on the accelerator side, and a full protective shutoff of Phenix
- Despite the foreseen and unforeseen difficulties, fantastic outcome of run16, achieving AuAu 200 GeV and dAu BES very successfully
- We look forward for the results but already now it was successful and fantastic adventure,
- Thanks to the dedication and remarkable expertise of all the BNL and CAD services and people. Thanks a lot for that.

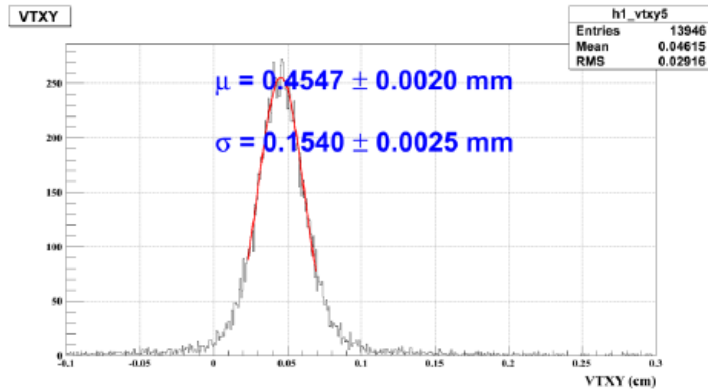
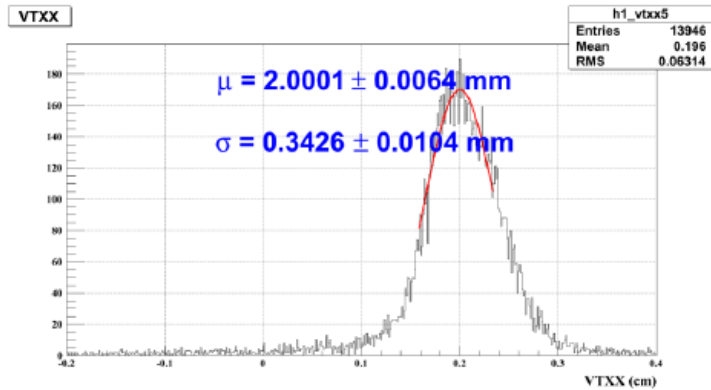
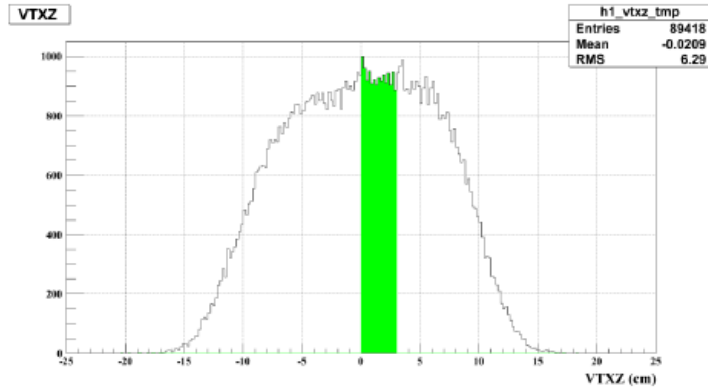
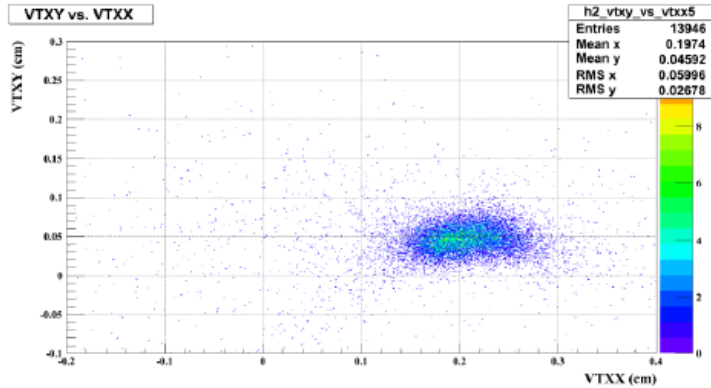
backup



« ~On line » vertex



Trigger: MB



0 cm < VTXZ < 3 cm